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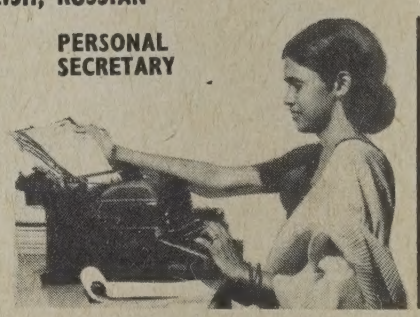

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167.5 cms.	60.1 Kgs.	152.5 cms.	46.8 Kgs.
170 cms.	62.7 Kgs.	155 cms.	48.2 Kgs.
172.5 cms.	64.5 Kgs.	157.5 cms.	49.5 Kgs.
175 cms.	65.5 Kgs.	160 cms.	50.8 Kgs.
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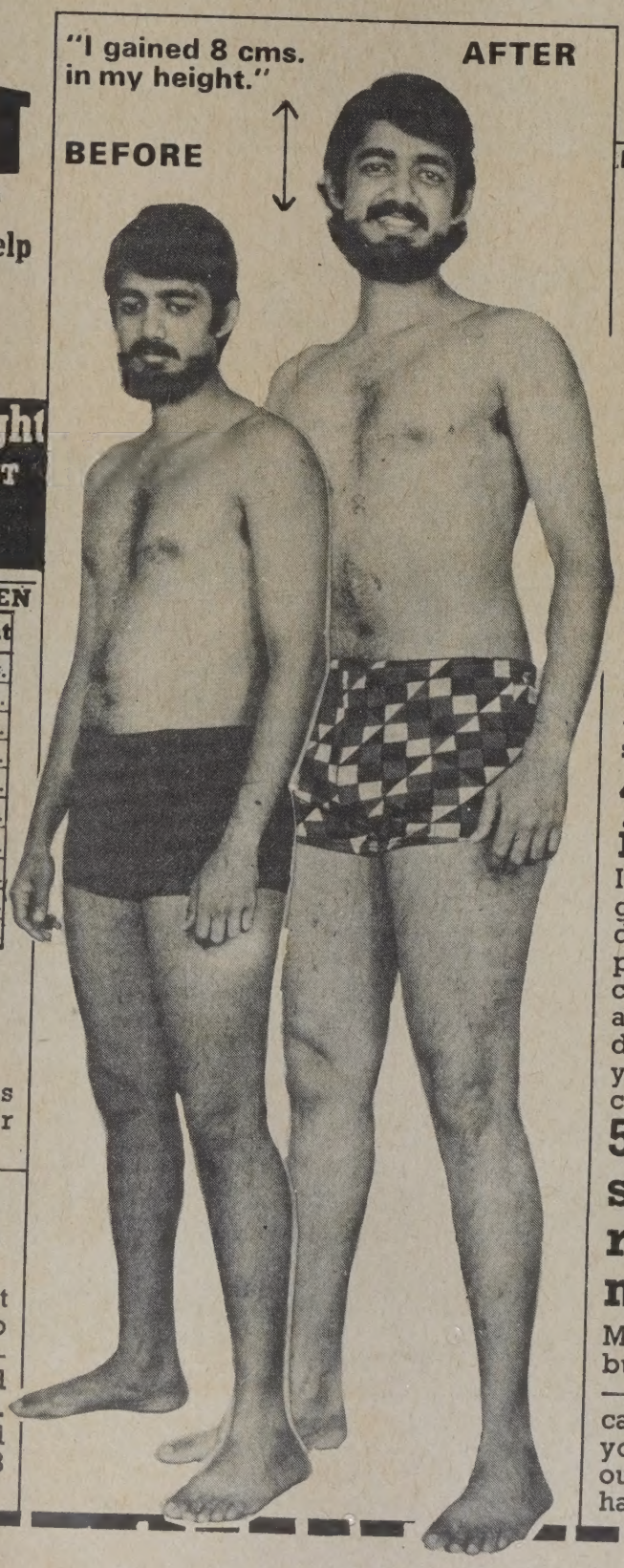

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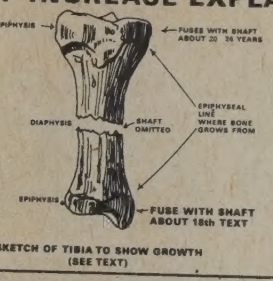

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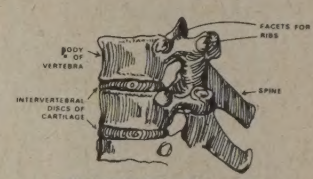

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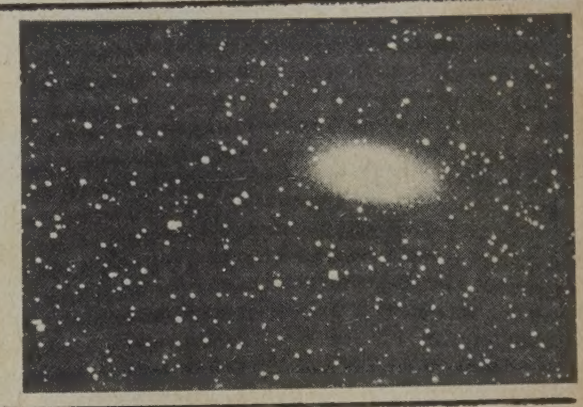

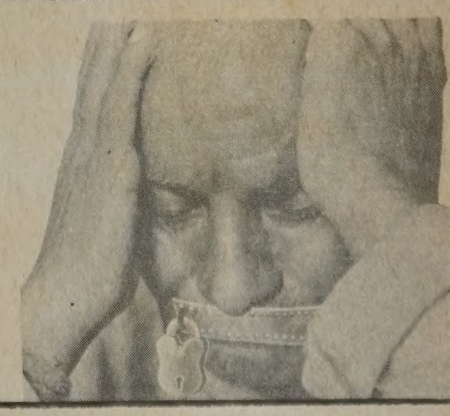

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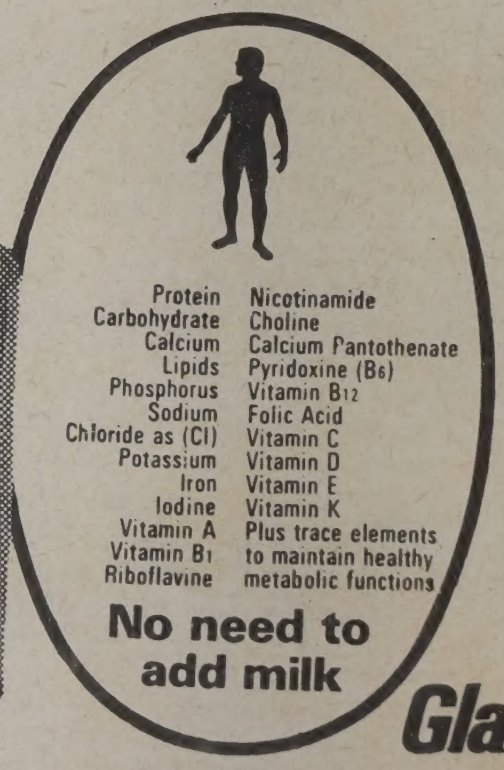

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n nurturing scientific ysticism?

Dr. Raja Ramanna's article " On rturing scientific excellence " (January 78) demands firm faith in certain esumptions. Blind faith in science and its wers may be as invalid in the existing cial reality in our country as are some of e ancient beliefs. Even the word xcellence ' itself should be clearly derstood with a new interpretation the *theory of relativity*. The same rdsticks of ' excellence ' should not be ed to assess scientific work in dustrially advanced and in industrially ckward countries and if it is done, the proach itself becomes unscientific.

I quite agree that social conditions do fect not only the growth of science, but en the use of scientific methods and, timately, the absorption of science in the ocesses of change and development. It precisely for this reason that the class of ople who call themselves scientists nnot live like the elite in a backward untry. Before insisting on their right to joy the facilities, conveniences and nditions available in advanced untries, scientists must also work for proving social conditions of the people a whole. Thus, their task is much more fficult than that of their contemporaries developed countries. They have to ltivate science and also work multaneously for its application for cial development. Unfortunately, our ite scientists have generally been very uch self-centred. They have been reaming about the conditions available in Vestern heavens but never cared about e material reality surrounding them. We ay have many scientific *Naradas* moving out in the *trilok* (three worlds) but ere are hardly any *rishis* working in sterity for the welfare of all. Excellence scientific rituals and pretences seem score over straight, simple and rposeful efforts for material development f social conditions.

Ivory tower scientists live in conditions f an intellectual desert. Their affluent ays of living, secretive methods of orking, mysterious international links and oolness towards the miseries of the asses of their native countries tarnish the nage of science. To common men, it oks like a magic capable of doing iracles here and there, now and then, but otally incompetent to solve their age-old roblems. The central task before the cademies is to free themselves of elitist hinking and to dedicate themselves to the velfare of the masses through the pplication of science and technology.

RAM PRASAD
Honorary General Secretary
Association of Scientific Workers of India
10, Rajendra Park, New Delhi 110 060

" If there are (as I doubt not there are) olitical evils which, like some personal sufferings, cannot be remedied by science, science at least proves to us that they are ncurable so as to calm our restlessness nder pain by the conviction that it is by natural laws that they are rendered insurmountable," wrote Auguste Comte in 19th century France. To Comte, the scientific elite was to be the final authority of what these laws (of nature) are and would indicate the degree to which the lot of the lower classes could be slowly improved.

More than a hundred years later, Dr. Ramanna makes out a case for just such a status for the scientist. Surely, in a hundred years we have learnt that to equate science with development *per se* is too simplistic and too inadequate an explanation for the irreconcilable picture of sophisticated science on the one hand and ignorance, superstition and oppressive poverty on the other!

Dr. Ramanna's picture of the Indian scientist is interesting — a poorly paid but highly sensitive, oppressed individual who needs to be treated with solicitude and concern. If an atmosphere of non-science exists today, who but the scientists are to blame for this? What have the scientists done to educate the public about science? What have they done to foster an awareness of science and the cultivation of a pro-science attitude? Whatever happens to the intelligence, the organisational capabilities and the application that scientists (one must suppose) possess when they come out of their laboratories or office? How many scientists have brought to bear their trained rational minds on issues of wider concern? Few scientists have ever been involved in public issues and fewer still are concerned about the public ignorance of what is happening in the world of science. Isn't this an inevitable outgrowth of the " nurturing of excellence "?

One does not dispute the fact that we cannot afford to nurture mediocrity. But that does not mean that scientists have to be handled with kid gloves. That a majority of them are employees of the government and are, therefore, barred from expressing opinions publicly appears to be a most convenient excuse for their nonchalant attitudes. But when the scientists' privileged position is challenged — as has been the case recently — they do complain loudly. The trouble is, it is only now in our hundred-odd years of exposure to modern science that scientists are being asked to account for their activities. The building of institutions of science has been effectively delinked from the growth of science, perhaps inevitably, but more probably, intentionally. And science, with its practitioners, has willingly become a pawn in the hands of vested interests.

The efforts of any scientist or scientific organisation should be to bridge the gap between science as a profession and science as an attitude. After all, the essence of science is in its productivity, in its application. The aesthetic appeal of a scientific solution is in no danger of being diluted by the scientists' awareness, concern and involvement in social progress. Science does not mean progress automatically: it is just a methodology that must be put to use to be effective. It is important that we should de-mythologise science. And this responsibility lies with the scientists and science associations.

Finally, I think Dr. Ramanna is being overly defensive about the question of nuclear explosions. By definition, a superstition is " credulity regarding the supernatural, irrational fear of the unknown or mysterious, misdirected reverence ". Surely, the stress on the evil aspects of peaceful nuclear explosions does not qualify by this definition.

PADMA PRAKASH
19, June Blossom, 60-A, Pali Road
Bandra, Bombay 400 050

Your initiative to start a debate on science policy is quite impressive. But, let us face it, it is hardly likely to lead you anywhere, except that, by doing so, you may enhance the market of your magazine. How many in this country, where most of the scientific activities are directly or indirectly controlled by the government, will be able to do plain-speaking? For instance, Dr. Atma Ram is quite prompt in quoting perfumes, cosmetics, toothpastes and beverages when asked about the areas where high degree of sophistication was sought in India unnecessarily (February 1978). However, when he is asked to name the technologies which, according to him, should be purchased from abroad, he evades the issue by saying that it depends on the situation and the anticipated advantages. He is apparently playing safe. If this is the kind of answers from the Chairman of the NCST, a scientist outside the government and chosen by the government for getting fair and frank advice, what justice do you expect from the rest of the scientific community?

Unless those who matter are able to argue freely and frankly, a debate will only illuminate personality cults, thus making science as well as the poor scientist suffer irreparable harm. If you are keen, you must first help in creating an atmosphere which is congenial to a purposeful debate. Surely, you can take that up.

RAM DATT SHARMA
Seismology Section
Bhabha Atomic Research Centre
Bombay 400 085

" On nurturing scientific excellence " is persuasive and refreshing, especially when Dr. Ramanna notes that the Indian National Science Academy " will recognise no other solution on scientific matters except those under the principles defined by science " (p. 17). A visitor to India, like myself, sometimes gets the impression that there is such a thing as " western science " which is somehow different from " Indian science ", and that " western science " is just one of the alternative approaches one might adopt if one so chooses. To take that view denies the universal nature of science itself. Surely, there is no Cambodian physics, Brazilian chemistry, or Dutch algebra! While thoughtful people in a " developing nation " may wish to honour and preserve their own past, some of it may not be worth preserving. If, as Dr. Ramanna says, " a large number of Indian

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scientists retain their faith in miracle cures," the burden of proof is on them to show that their faith is scientifically warranted. Repeated announcements about the alleged brilliant insights of ancient yoga, the unexampled results of homeopathy or ayurvedic medicine and the like, need to be tempered by the recognition that " objective statistical verification of all success is an essential part of science " (p. 17). Alternative systems must not be tolerated if they are scientifically false.

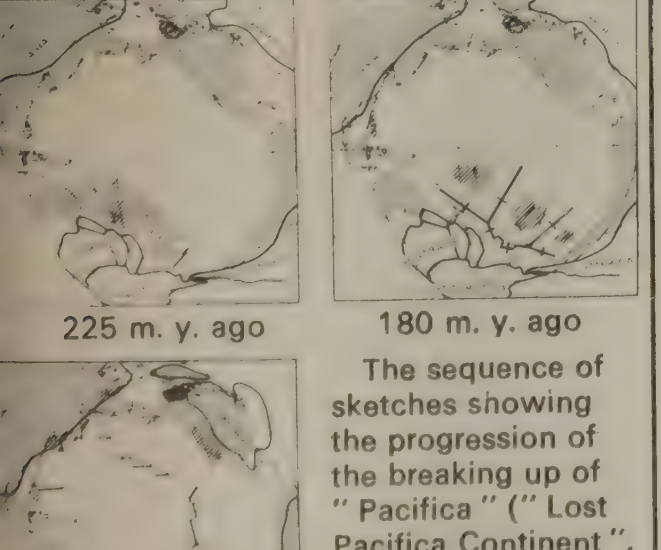
While scientists deserve respect and " solicitude ", it seems to me that they have public responsibilities as well. One great service they can do now is to repudiate utterly the flagrant nonsense of astrology. Should each Indian scientist openly reject the practice of astrology even in his family rituals, the course of science would be advanced in this great land. It would take individual courage. It is three hundred years overdue.

WARREN E. STEINKRAUS
Department of Philosophy
State University College
OSWEGO, New York 13126, USA
Visiting Professor of Philosophy
Banaras Hindu University, Varanasi 221005

"Two leaves and a bud"

Following the discovery of wild tea plants in Assam, tea plantations were also established in northern India at Dehra Dun and Kangra through the untiring efforts of Dr. William Jameson, Superintendent of the Botanical Gardens, Saharanpur, towards the middle of the 19th century. These plantations are still marketing their produce. Their green tea was once very popular in the West Asian countries. The existence of tea industry in these regions of northern India has been overlooked by the author, Dr. K. K. Mitra, in his article. " Two Leaves and a Bud " (January 1978).

K. M. VAID
Forest Research Institute, Dehra Dun



The sequence of sketches showing the progression of the breaking up of " Pacifica " (" Lost Pacifica Continent ", January 1978, p. 21) and the linking of the fragments with the continents on the East and the West was wrong. The second sketch here refers to the position 180 million years ago, and the third, 65 million years ago.

■ Prof. Yash Pal is Director of the Space Application Centre of the Indian Space Research Organisation at Ahmedabad and not Director of the Physical Research Laboratory ("Awards & Appointments", February 1978, p. 59).

Caffeine and food intake

6-Hydroxydopamine (6-HDA)-lesioned rats do not increase their food intake when administered 2-deoxy-D-glucose (2-DG). But it was recently (*Nature*, **267**, 174, 1977) observed that 2-DG with caffeine (" Tea in Medicine ", January 1978) increased the food intake of 6-HDA-lesioned animals. The failure of 2-DG to increase food intake was ascribed to inadequate activation of the central catecholamine receptors. Perhaps, caffeine has the ability to potentiate it. Further experiments will be required to fully elucidate the mechanism of this phenomenon.

P. C. BHATTACHARYYA
Vidyasagar College
39, Sankar Ghosh Lane, Calcutta 700 006

The drought weapon — is it a fantasy?

In his review of my book, *The Weather Weapon* (November 1977), Dr. Y. P. Rao writes in the last paragraph : " The author creates a scare of weather modification experiments and operations. Such a scare may beset national programmes with several problems ". Since Dr. Rao has raised this issue, I would like to respond by offering clarification on a typical project on which documents like my book may have a bearing on decisions.

The World Meteorological Organisation has proposed an international weather modification study called " Precipitation Experiment " involving an investment of several tens of millions of dollars with India as one of the possible venues for the experiment. In such colossal projects, in spite of best intentions, the national and environmental safety considerations cannot be underplayed. Therefore, it is not unlikely that the aspiring implementing organisations in some of these countries might have been advised appropriate levels of caution. The general proposal, which has been openly discussed in international forums, is as follows : several profusely instrumented aircraft of colossal capacity, typically represented by the C-130, are proposed to be deployed with extensive international participation to make a few thousand cloud-seeding sorties — to douse the clouds with silver iodide and other seeding agents for a few rainy seasons in a row. Regarding such projects my book only prescribes caution about ' space-time persistence effects ' of cloud-seeding and the ' zero-sum game principle ' pointing out to a creation of conditions conducive to drought in down-wind areas. How can advocating such caution be misinterpreted as creating a " scare " which " may beset national programmes with several problems " ?

An examination of the quotations made by Dr. Rao with reference to the actual context in which they were presented in my book (pp. 6, 62, 104 and 127) would reveal that they are either partial or out-of-context or even falsely attributed. I would like to give one example of each of these three categories. Take for instance, his partial quotation from p. 102, referring to one of my simulation studies, leading to his unkind inference : " This secret work would indeed be a valuable addition to the arsenal of any country ! ". My simulation studies carried out at TIFR are not secret. In fact, the result of one of the investigations was outlined in SCIENCE TODAY, Vol. 11, No. 1, July 1976. A paper giving the details of simulation concerning the modification of cyclones, which is an extension of the published simulation studies of the energetics of a cyclone by Li Peng, Kuo, Rosenthal and others, is being published. I wish to state that I was actively involved in working out international safeguards against weather weapons in the Pugwash Conference and other such forums. In the context in which my simulation work is described in my book, it is more than apparent that it was carried out to understand national security implications. It is in this perspective that his out-of-context quotation of a half sentence from p. 127, " a mild chill down the spine ", needs to be corrected. The latter part of the sentence omitted by Dr. Rao reads as follows : " he [the reader] would join the author and scores of others in the crusade against irresponsible weather and climate modification ". Further, Dr. Rao has made the following attribution : " by tampering with these, the Indian monsoon can be dried out " ; this is far different from my description of " the possibility of creating drought conditions ".

One of the main objections raised by Dr. Rao is about my use of the word, " steering ". It is mathematically convenient to use the term " steering " as a time-function operating on a vector field consisting of direction, kinetic energy, potential energy, etc. The wind velocity, which is a function of the components of the steering vector, was reduced by seeding, according to published research reports.

Also, while Dr. Rao acknowledges the flash-flood weapon possibility, he belittles the drought weapon possibility. A drought weapon creates disorder in cloud systems, whereas the flash-flood weapon has to create order. The former is relatively easy. It is easier to modify clouds at random or create orphan anvils at random or to carry out other such procedures behind the drought weapon possibility than to create and direct a flash-flood weapon which requires accurate dynamic seeding and merger over the target. Dr. Rao himself concedes that the latter requires considerable air superiority.

Dr. Lowell Ponte, formerly of the Pentagon, brought out his revelation of a Pentagon activity near Cuba for causing drought by " squeezing " clouds before they reached Cuba. Recently it was reported that a spokesman of the US Department of Defence confessed before a Congressional Panel hearing that the US had indeed wielded the drought weapon over Cuba, though as an experiment.

Was it ' fantasy ' that President Ford went all the way to Vladivostok to discuss with Mr. Brezhnev the banning of weather weapons ? That member countries of the United Nations fought over every clause in the CCD Draft International Resolution on banning weather weapons ?

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CZECHS ERADICATING TYPHOID

Typhoid and paratyphoid erupt because of the healthy individuals who harbour the disease germs. These carriers do not suffer from the disease and drugs do not rid them of the causative organisms. If these people could be isolated, reasoned Jiri Havlick and Vaclav Panek of Charles University, Prague, Czechoslovakia, the disease could be contained. The Czech scientists listed out guidelines to do so. By this method they have almost controlled the disease, they claim.

In Czechoslovakia, carriers are regularly examined by hygienists and kept isolated from large communities. They are not permitted to go to spas or take part in mass recreational schemes and are not allowed to work in areas where they could spread the disease. If they are hospitalised, they are confined to infectious diseases wards.

Removal of the gall bladder rids carriers of the germs. Therefore, part of the treatment consists of removal of the gall bladder with the simultaneous administration of antibiotics.

On discharge from the hospital, the patients are kept under hygienic supervision for another year after which they undergo medical tests before being declared healthy. According to the Czech scientists, even people suffering from advanced diabetes, cardiovascular disease, hypertension and other diseases can be treated this way.

NUT POWER

The power hungry world is reaching into every available resource to keep going. The Philippines hopes to tap a very uncommon source — coconuts. The wastes from coconut processing will be used to fuel power plants.

The wastes will be processed under heat to provide combustible gases which will be used to drive steam turbines. Power plants are to be set up at the end of nut processing lines.

A pilot plant of 1·5 megawatts is being set up at a small town, Infanta, and it is expected to become operational this year. The 6·5 million tonnes of wastes of the coconut processing industry are equivalent to 2 million tonnes of diesel fuel. And what's more interesting is that nut power is clean.

MAKE HYDROGEN FROM MAGMA

You pump in water and draw up hydrogen — a simple answer to all your energy problems. A group of physicists and geochemists at the Sandia Laboratories, Albuquerque, plans to use the hot magma under the Earth's crust for dissociating water. The water pumped in would react with the ferrous iron in the magma and oxidise it to ferric iron, and, in the process, hydrogen will be liberated. If this method proves feasible, we no longer need depend on natural gas for the production of hydrogen.

The efficiency of the method depends on the ferrous iron content and the temperature of the magma. The best magma is the basaltic magma found under the sea bed — containing 10 to 12 per cent ferrous iron. Ten to 20 holes drilled into a magma containing 12 per cent ferrous iron could yield 500 million cubic metres of hydrogen per year. The magma found under the continental crust contains less than 7 per cent ferrous iron.

By adding biomass — 10 per cent — to the injected water into the magma at 1,300°C, the gases drawn up would include 10 per cent hydrogen, 1 per cent carbon monoxide, 4 per cent carbon dioxide and traces of methane. At 600°C, the methane portion increases and the hydrogen content would be 2 per cent. Cooler magmas are not worth using. As for the biomass, it can be any organic waste: sewage, straw, garbage, seaweed, etc. Undersea magma — there are some chambers within 2 to 3 km of the ocean floor — should be accessible by extending today's drilling technology, say the Sandia scientists.

SLIMMER BABIES

According to the findings of a British study (*Lancet*, 26 November 1977) babies today are slimmer than what they used to be nine years ago. Perhaps the recent warnings about fat babies growing into fat adults have checked overfeeding. There is also a marked increase in breast feeding and it has been found that introduction of solid foods is delayed.

Andrew Whitelaw of Northwick Park Hospital, Harrow, UK, says that babies born fat need not stay that way. Whitelaw in his study of obesity in 114 children found that "groups of infants who were obese, normal or thin at birth had virtually indistinguishable mean skin-fold thickness at one year". Skin-fold thickness is a measure of obesity. This finding discounts the recent theory that overnutrition in late pregnancy permanently affects the baby's fatness.

A TIP TO THE "FILTER TIPPED"

The connection between the price of cigarettes and their consumption is now firmly established. Two British Researchers, A. B. Atkinson and J. L. Townshed, have calculated that total cigarette consumption could be brought down by 40 per cent: 20 per cent of it through a 56 per cent price hike on cigarettes, 10 per cent by restricting advertising and a further 10 per cent from a sustained health-education campaign.

Smokers' preference for filter or plain cigarettes, again, depends on their prices. Increasing the price of filter cigarettes may boomerang on the smokers' health because they may go in for the plain ones.

Though filter tipped cigarettes are said to be safer, evidence on the relative safety of plain or filter tipped cigarettes is scanty. In Britain, about 85 per cent of cigarettes sold are filter tipped and the Royal College of Physicians calculated that in the 10 years, 1965-75, the change to filter tipped cigarettes of low tar yield was substantial enough to reduce the average smokers' tar intake by 43 per cent.

For smokers of filter tipped cigarettes, the risk of lung cancer may be reduced by as much as half or as little as a fifth compared to those smoking plain cigarettes. But further research is needed to measure the benefit exactly, according to a report in the *British Medical Journal* (3 December 1977, p. 1439).

THE EARTH AND THE MOON . . .

. . . are seen here together for the first time in a photograph. The Voyager spacecraft, some 11·6 million kilometres away from the Earth on its way to the Jupiter, snapped this couple from directly above Mount Everest (not seen because it is in the night part of Earth in the picture) on 18 September last year. The image of the Moon had to be brightened three-fold compared to that of the Earth.

SECOND SIGHT

A normal-sighted person sways more as he moves in a totally dark room than in a lighted room. This is because we partly rely on visual clues to maintain our balance. When the centre of the field of vision — the 'seeing' portion of eye — is blocked by cardboard, the person can still maintain his balance. That means, there's more to sight than we know of. Don't we often walk around obstacles without actually seeing them?

Herschel Leibowitz of the Pennsylvania State University, USA, examined the visual capacity of several people with large blind spots. He placed the subjects in a large striped cylindrical drum. The subjects felt themselves moving when the drum was rotated about them; they felt it even when the seeing portion of the eyes was blocked. Normal persons allowed to see only through the centre of the visual field could hardly detect any motion. Based on this and on studies with other gadgets, Leibowitz suggests that there is a distinct second visual system which he calls the ambient visual system.

Two separate regions of the brain control the two systems. Also, the sensing of two systems differ. The normal (or focal) vision helps us to focus on objects. It is controlled by the outer cortex of the brain. In the ambient system perception occurs at the outer edges of the retina and it is believed to be controlled by a region in the deep midbrain. Injury to the brain surface destroys the focal vision but not the ambient vision. Leibowitz has not yet studied any totally blind people but he feels that they use their eyes more than they are aware of.

The two visual systems normally interact but they can also act independently. Leibowitz suggests that doctors testing vision should test both systems, for this would help to identify brain problems and might lead to specific treatments.

TO BE ALLOWED TO DIE

In burn accidents, the prognosi almost immediately evident. S mortality statistics are more detailed complete than for other patholog conditions, it's quite easy to say whe the person will survive or not.

At the Burn Center, Los Angeles Cou University of Southern California Med Center, hopeless cases were given choice of intensive or ordinary c This right to a free option was sta three years ago under an innova programme. Burn victims, howe serious, are usually alert and ment competent on arrival at the hospita

No family members are allowed in counselling room where the Cent most experienced physicians explain gravity of the condition to the pati The most frequent question the pati asks is, " Am I going to die? " To question the physician answers, " No in the past, of your age and with y

PREGNANCY PREVENTS CANCER

If animal experiments are any indication, it does. It is well known that women who have their first babies before the age of twenty are less likely to develop breast cancer. This may be because fetal cells that escape into the maternal blood stream immunise her against tumours. Fetal cells are like tumour cells; they carry antigens on their surface and these induce antibody — killer cells — formation.

P. B. Medawar and Ruth Hunt of the Clinical Research Centre, Harrow, UK, simulated the protective mechanism of fetal cells in mice (*Nature*, **271**, p. 164). They injected five groups of mice with fetal cells and with a tumour-inducing chemical, methylcholanthrene. The inoculum was given once 14 and 7 days before, simultaneously with, and 7 and 14 days after injecting the tumour-inducing chemical, respectively, in each batch.

The Harrow researchers found th the time of immunising in relation t exposure to the chemical had a cle effect on tumour development: th later the immunisation, the greater wer the number of tumours formed. Th mice that had been immunised earlies had the least number of tumours. And in fact, inoculum given after th chemical treatment enhanced tumou development. This has a parallel i human epidemiology. Women who hav their first pregnancy after 33 are a greater risk (than childless women) o developing breast tumours. The earl pregnancy perhaps arouses immunity before application of the oncogeni stimulus. It has been shown in rats tha animals that had borne litters were less prone to tumour formation when fed with dimethylbenzanthracene, another tumour-causing chemical.

POISONS AND THE 'RESTING' BREAST

Breast-fed babies get a lot more than just the mother's milk. Even foreign substances like some drugs get passed on to the baby. This does not mean that only actively secreting breasts absorb extraneous chemicals. It has now been found that a non-active breast, too, can collect and store these materials. Even during its quiescent period the breast glands of women secrete and reabsorb small amounts of fluid. Nicholas L. Petrakis, Neal Castagnoli and coworkers at the University of California, San Francisco, report (*Science*, **199**, p. 303) that nicotine can get concentrated in the non-secreting breast. And if other environmental chemicals were to be concentrated in the breast similarly, they could pose a cancer threat. " Nicotine can be a model for other xenobiotics — for a broadspectrum of foreign substances ", the researchers explain.

Few drops of the breast fluid were pumped out from non-lactating smoking and non-smoking women and the amount of nicotine was measured. By means of sophisticated techniques, even such small amounts as 25 picograms (one picogram = 10^{-12} gram) of nicotine could be measured. Two non-smokers had no nicotine in the breast. In the four smokers, nicotine in breast fluid was found to be much higher than in blood plasma. Cotinine (a nicotine metabolite) was present in the same concentration in blood plasma and breast fluid in the smokers.

In their experiments, barbiturates and several foreign fatty acids have been demonstrated in breast fluids. So far we do not know of any link between smoking and breast cancer. Perhaps, this is because women have been smoking only for a short time. The link, if it exists, may become obvious in the next 10 or 20 years.

size of burn, has ever survived his injury either with or without maximal treatments."

Sharon Imbus, a registered nurse at the Center, and physician Bruce Zawacki kept track of the 24 critical burn cases admitted in two years. Of these, 21 rejected intensive care; they wished to be allowed to go "quietly and comfortably". These patients were given private rooms and were allowed unlimited visiting hours; the patients made the best use of their time by making proper plans, reparations, apologies. They were only given pain-relieving medicines. The other three were put in the intensive care unit. All 24 died.

The option, however, is not extended into the pediatric ward, because for one, children can't choose and, two, in their case, the prognosis isn't that well defined and the mortality rates of children burn cases is falling "more rapidly than can be reported".

DARKNESS IS GOOD FOR POULTRY FARMS

Poultry farmers in Canada will now be able to save a lot of money: on energy bills, animal feed and on the costs of cutting the birds' beaks. Researchers at the Agricultural Research Station at Kentville, Nova Scotia, have found that chickens raised in the dark grow faster on low-protein diets: they are also less aggressive and do not fight each other.

By trying out different lighting levels and manipulating the protein content of the chicken feed, they found that a 15-20 per cent protein cut did not affect the birds' growth if kept at the lowest illumination levels — 1/10 of a foot-candle. The low protein diet will save $36 per tonne compared to the normal fattening diet which is given to the birds after the first four weeks of life. And, of course, there will be savings on lighting.

PHOBOS BY MARSLIGHT

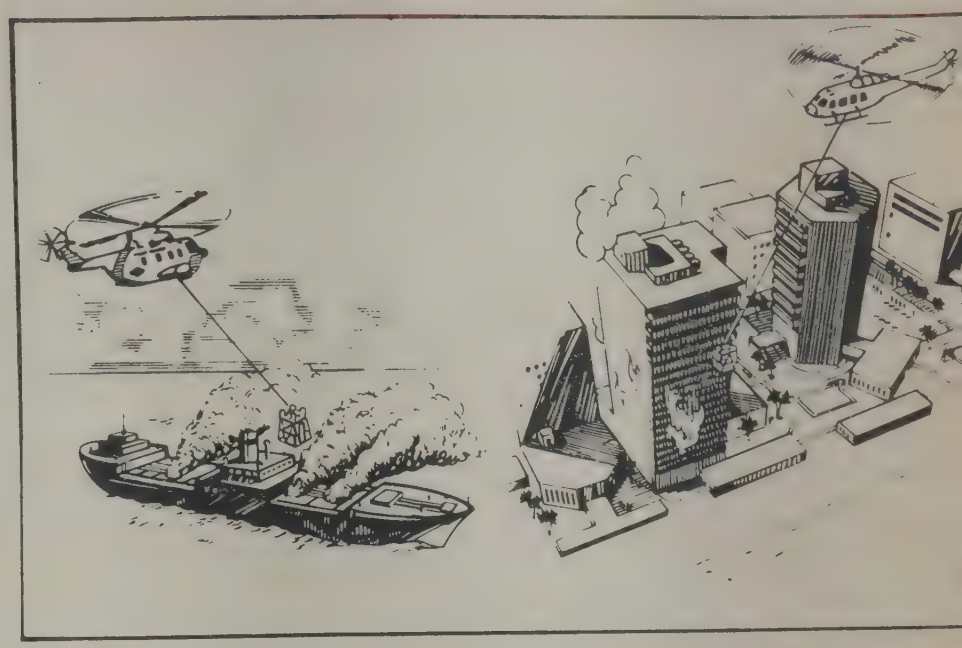
The vital statistics of Mars's moon Phobos sent down by Mariner-9 in 1971 have now been confirmed by the Project Viking scientists. The Viking Orbiter 1

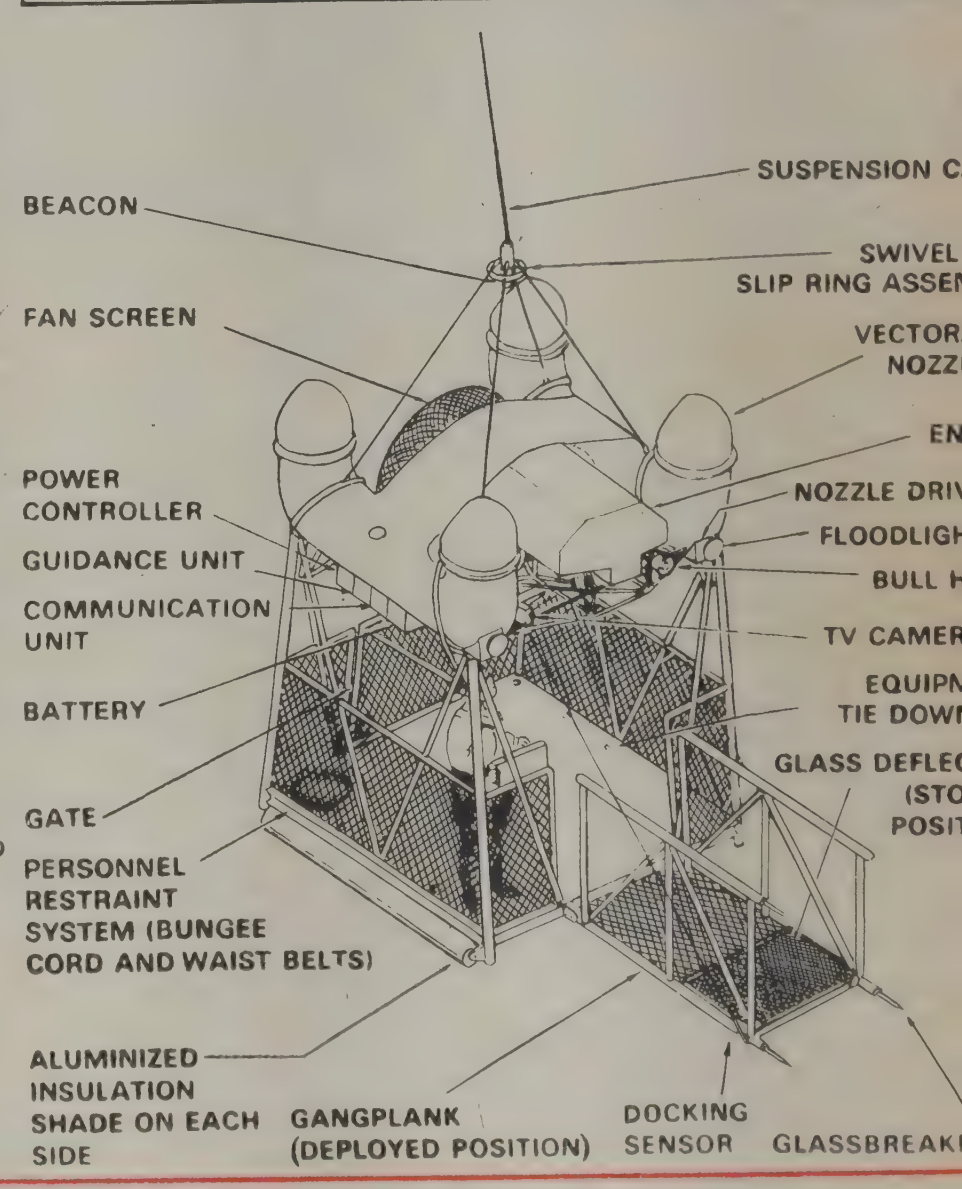
photos taken from various angles show only a small difference. The volume and shape differences add up to 10 to 20 per cent only. The full disc photograph shows the sunlit portion (bottom) as well as the night side of the non-spherical moon illuminated by a pale glow of sunlight reflected from the parent planet. More accurate calculations will be possible based on several close flybys in a few months' time.

HELP FROM THE AIR

Inaccessibility of trouble spots is a drawback in any rescue operation. Fire on oil rigs, earthquakes and flood disasters fall into this category. Also, when fire on a lower floor cuts off access to the upper floors, airlift and "flying fire engines" may be the best means of help. Macdonnel Douglas of the USA is developing a helicopter-suspended system for dealing with such situations.

The rescue vehicle is tagged on by a cable to the copter. It is self-propelling and once near the fire area, the helicopter can stay clear of the smoke and heat while the cage propels itself up to 80 metres to the actual rescue point. The rescue vehicle has place for 24 men — usually 4 to 8 rescue men like firemen, paramedics, etc. and 16 other persons. It is voice-linked to the helicopter.





SWIRL ALCOHOLISM AWAY

How can one get rid of the addiction? Drugs often have violent side-effects and total abstinence helps only the motivated few. Clive Mellor and his student Hubert P. White of the Memorial University in St. John's, Newfoundland, have successfully used an aversive conditioning technique to cure alcoholism.

In their report in the *American Journal of Psychiatry* (January 1978), the scientists describe how they induce motion sickness in the addict. After a 48-hr abstinence, the addict is given a taste of alcohol and then seated blindfolded on a rotating chair — the type used for aerospace training — and swirled for between five and 20 minutes until motion sickness is severe — just short of causing vomiting. They treated 10 hospitalised alcoholics this way twice a day for six consecutive days. The induced motion sickness usually died away within the following 10 minutes and no other side-effects were found. Six months after the treatment, the researchers found only two had returned to the bottle. The others did not return to drinking or felt nauseated after drinking. In the two cases that failed, the addicts had managed to get rid of their conditioning after several bouts of drinking. In such cases, the researchers suggest, longer initial training or booster follow-up sessions could help.

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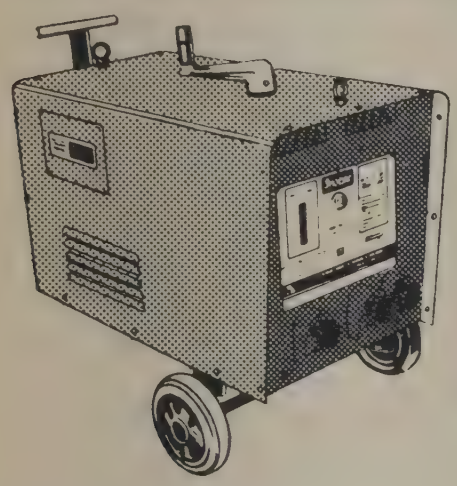

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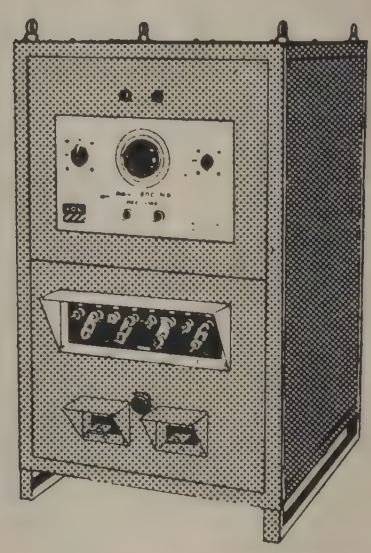

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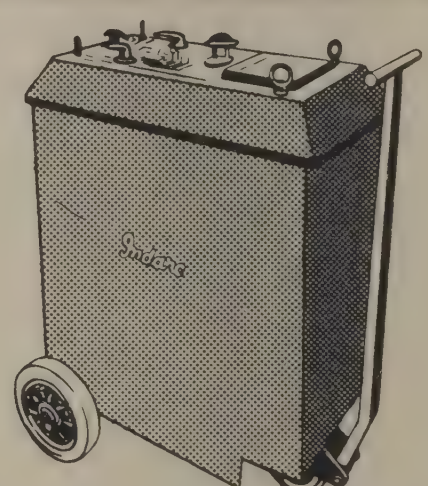

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AXIAL-FLOW UNITS

We should, therefore, take another critical look at our low-head hydro sites

M. V. PANDIT

IN the 1950s, the Central Water and Power Commission carried out a survey of the hydro power potential in India. And, in terms of economically feasible projects, it placed this potential around 41,500 megawatts (MW). Today, the total installed capacity of hydro power stations in the country is much less — 9,100 MW, with another 3,000 MW under various stages of manufacture and installation.

Considering the status of the hydro power equipment technology at the time of the survey, the Commission, evidently, could not have arrived at a higher figure than 41,500 MW. Its estimate had excluded several low-head, or low-height, small capacity sites because it considered them uneconomic. But with the oil crisis and the steady rise in the cost of alternative sources of energy, the criteria for economic feasibility are beginning to change. Low-head hydro power sites, widely scattered over the country, may now form a potentially large source of energy. In fact, of the several studies made of such low-head hydro power installations in recent years, one places the potential from them at as much as 10,000 MW. This is why there is a renewed interest now in axial-flow turbine-generators, which, though invented three or four decades back along with other turbines, were allowed to languish.

Water power has been used since ancient times, locally and for mechanical purposes. It was the success of electrical transmission over long distances that triggered largescale hydro power development about the beginning of this century. By 1920, the three main types of water turbine used today — Pelton (Fig. 1), Francis (Fig. 2) and Kaplan (Fig. 3), all named after their inventors — had been well established. Another class of turbines, where the water flows axially without any change in direction unlike in the other turbines, had also been invented. These were called axial-flow turbines. But they did not prove popular. The reason was purely economic. Improvements in design and construction of turbine and generator components resulted in greater efficiency and reliability. They were also accompanied by a steady trend towards larger power units. Since the cost of generation equipment (in terms of rupees per kilowatt) comes down as the power rating, or the capacity of the unit, increases, axial units lost ground to larger, other types of units.

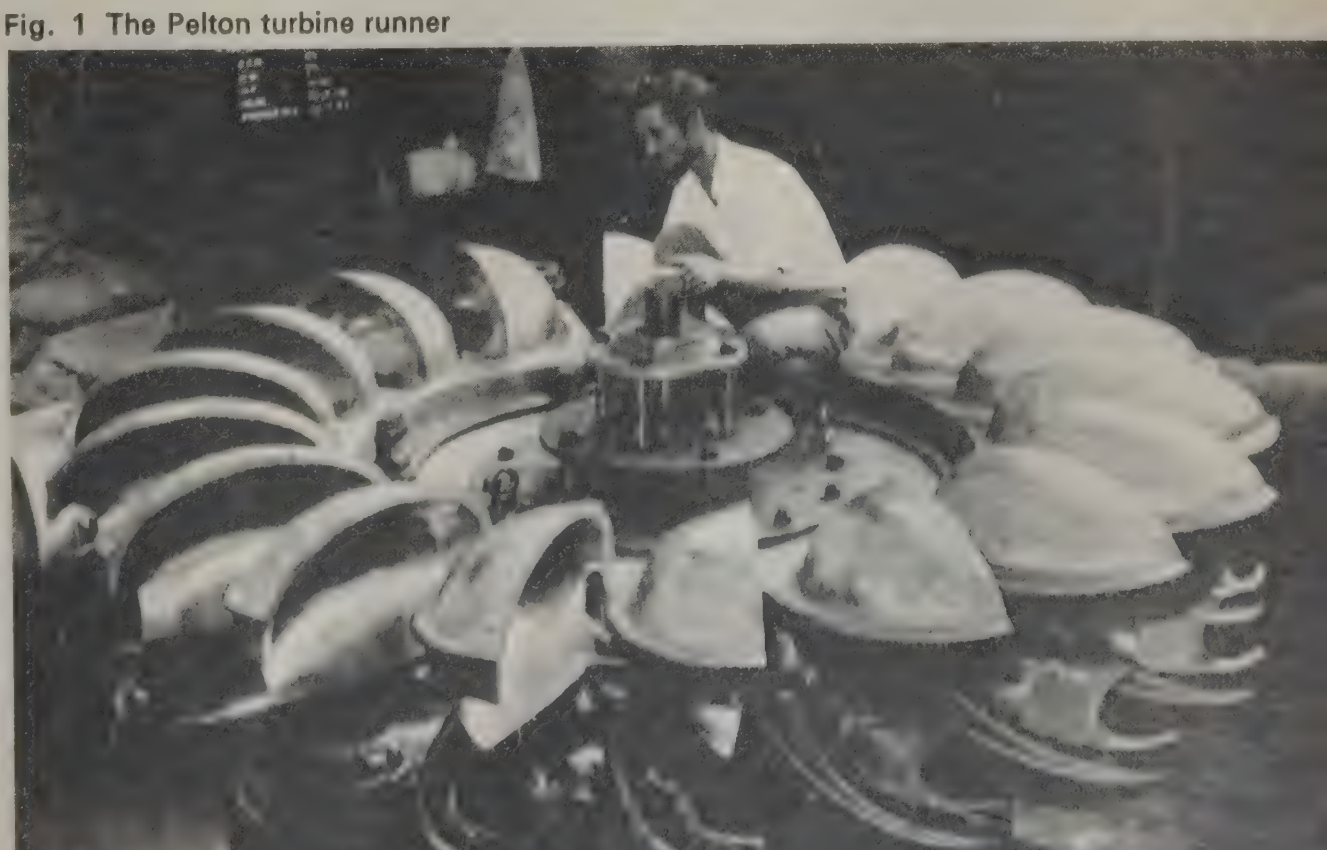
But today the trend is somewhat different. Axial-flow units are proving more efficient and economic than the other turbines for low-head hydro power sites.

Unlike high-head installations, which are concentrated in the hilly regions, sites for low-head installations can be found everywhere in the mountain regions, plains or even at the sea-level. They may range from micro sets (less than a megawatt) to the largest axial-flow turbines (up to 50 MW). Also, low-head hydro power sites can be close to power consumption areas, which is an advantage. And in water-logged areas like the Sunderbans in Bengal or remote hilly regions such as Ladakh, low-head installations are often the only source of energy.

Besides the firm power from axial-flow installations, they can often be used to meet peak load demands and to supply priority power in the event of power failures on the grid. Power plants of this kind can be designed for fully automatic operation and remote control.

Non-conventional energy from tidal schemes is another important application for axial units. The French La Rance Tidal Scheme, using axial-flow turbines, with 24 units of 10 MW each, has attracted world-wide attention; it has been operating since 1966. The units are designed to run both as pumps and generators. They can generate power during periods of peak demands and store energy by pumping water to a higher level at other times. Another interesting use of axial sets is at the Deisisan plant on the

Fig. 1 The Pelton turbine runner



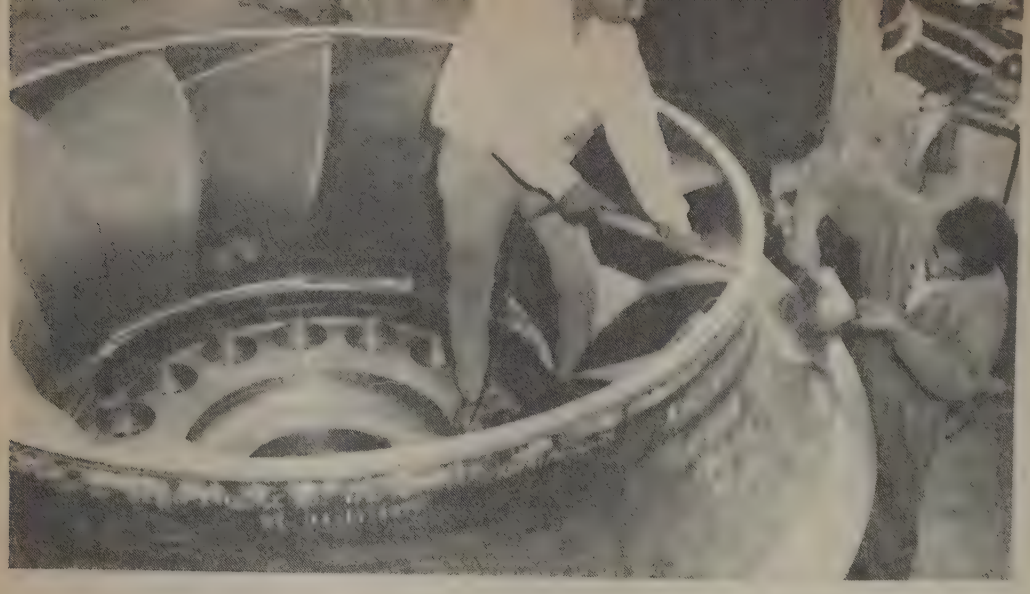
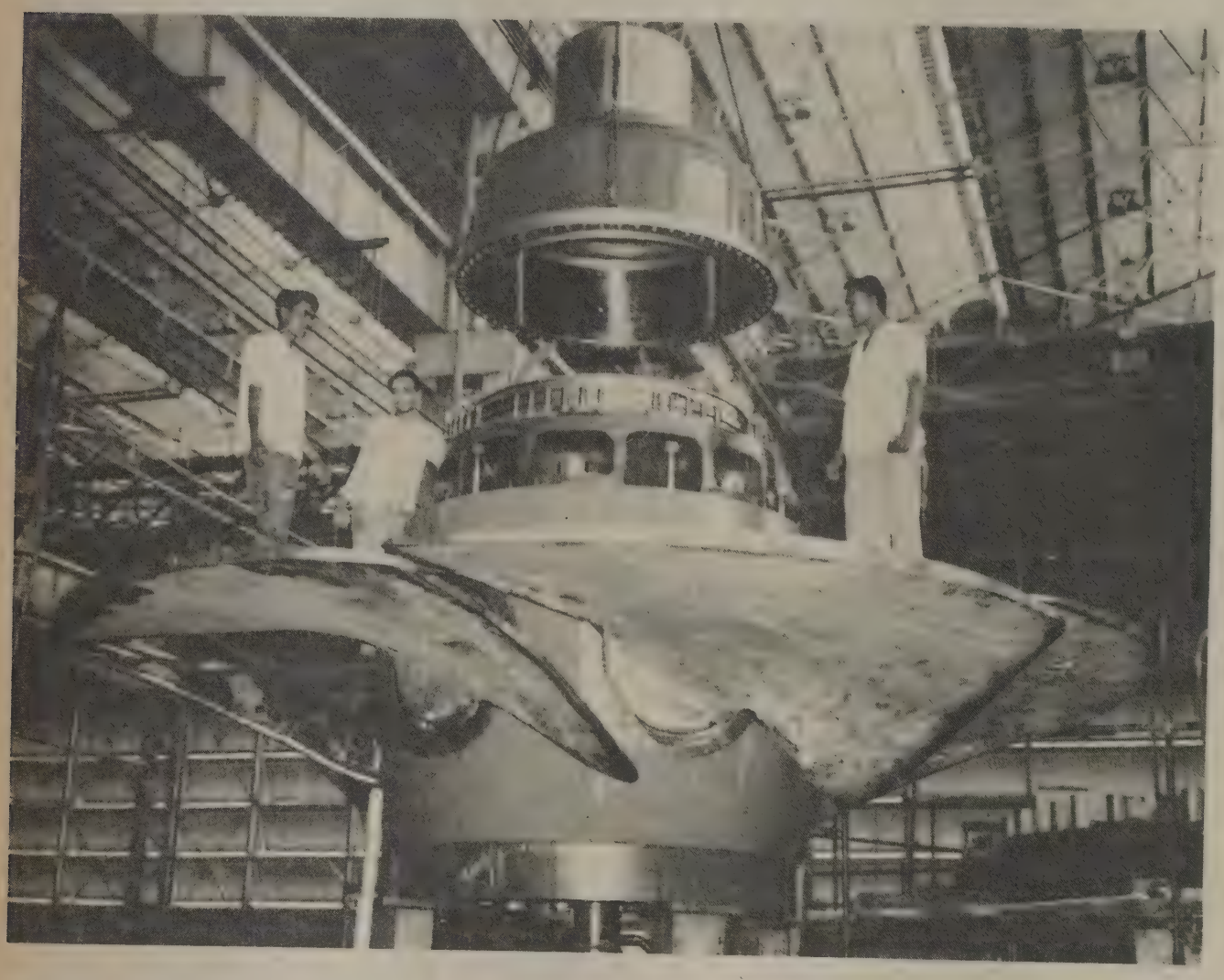


Fig. 2 (Left) The Francis turbine runner

Fig. 3 (Below) The Kaplan turbine runner with adjustable blades



Neckar river in West Germany. The unit pumps water when the river flow is low so that water needed upstream to cool the thermal plants does not get depleted.

Many of the rivers in India are monsoon-fed and, hence, seasonal. But seasonal power generation can relieve thermal plants for maintenance work and for boiler shutdowns during statutory inspections.

The axial-flow units also do not suffer from such major drawbacks of high-head installations as the unpredictability caused by landslides, tunnel collapses, etc and the consequent delay and high costs of civil engineering work. Many hydro projects, specially in the Himalayan region, have suffered long delays from such causes. Since axial power sets utilise mainly the run of the river, and have, in many cases, been incorporated in the spillway itself, they are also quicker to install.

The development of axial units in India seems to be bogged down by the "egg-or-chicken" syndrome. There is a capability to build the unit, but the manufacturers would not start work unless they have a firm order, and electricity generating agencies would not place firm orders unless they have operational experience. Axial-flow sets have already proved themselves as sound commercial propositions. We should, therefore, take another critical look at our hydro resources, especially the low-head type. But it must be emphasised that hydro power exploitation should be planned taking the entire river basin as a unit so that all possible sites for power development are fully exploited in a phased programme. The low-head schemes will then be assured of adequate base flows for operational efficiency.

Difficulties in low-head development

Why have not low-head hydro developments caught the eye of the planners? This is because, to produce each kW of power, a low-head installation requires a huge quantity of water compared to high-head installations. Low-head insta tions also have low-speed mach which push up the size and, co quently, the cost of the genera equipment per kW of power produ But there are other factors wh counterbalance these, and make ax flow units economically accepta

The level of water in a river o reservoir normally fluctuates. T means a large percentage variat from the design head, which cau problems in turbine behaviour. I Kaplan turbine, this is overcome using adjustable pitch runner blad Such blades maintain a high efficien over wide variations in head. Adju able pitch runner blades can be used axial units also to give a uniform effi ency rate over wide variations in hea

In a typical Kaplan installatio water from the reservoir is led a spiral casing in a horizontal pla (Fig. 4). From the spiral casing, t water flows radially inwards throu the guide vanes (the vanes guide wat flow so that it impinges on the turbi properly) to a vertical-axis turbine ru ner. The water flows over the Kapl runner blades axially downwards an with yet another right-angled tur through the draft tube to downstrea This tortuous flow of water results loss of energy which, in turn, affec the efficiency of the turbine.

In an axial-flow turbine, the wat flows from upstream to downstrea without changing direction (Fig. 5 Because of this purely axial flow onl the capacity of the machine can b increased by about ten per cent com pared to the Kaplan turbine for th same head. The main attraction of th axial-flow units, however, lies in th

Fig. 4 The direction of water flow in a Kapla turbine. Sectional elevation (top) and the pla (below)

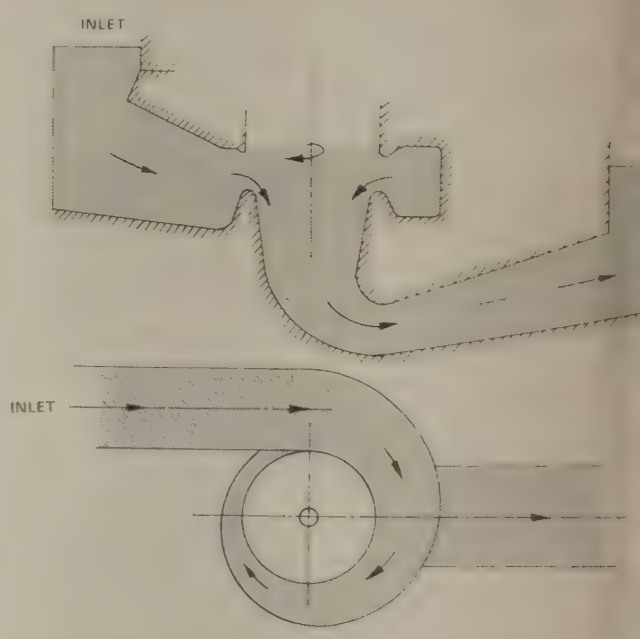
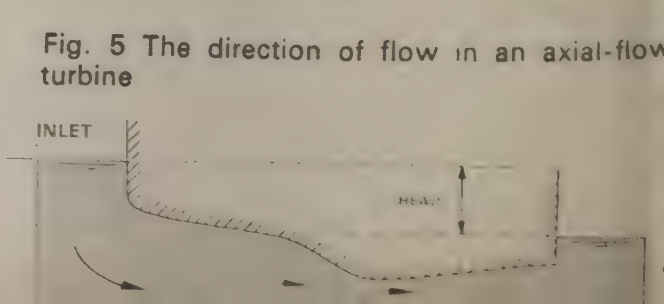


Fig. 5 The direction of flow in an axial-flow turbine



SOME BASIC CONCEPTS

To appreciate the role of axial-flow units, it is necessary to know some basic concepts of the hydraulic and electrical principles involved.

The power from water flow is due to gravity. The flowing water turns a turbine, which, in turn, is coupled to an electricity generator. The power available is directly proportional to the product of the quantity of water flow per second and the height or head of this flow. It means that for the same quantity of water flow, more power will be available if the head is higher. With a higher head, the turbine attains a higher speed. And with higher speed, the cost of the generator coupled to the turbine is lower.

How does one choose the type of turbine for a given head of water? This can be conveniently done on the basis of the specific speed — the speed of a geometrically similar turbine runner at which it can generate unit power under a unit head. The specific speed is thus a characteristic of the geometric profile of a turbine runner. The typical values for different types of turbines are: Pelton — 14 to 60, Francis — 80 to 300, Kaplan — 250 to 600, and axial flow — 450 to 1,200.

In most cases, the turbine in a hydro power plant is directly coupled to a synchronous generator. The turbine runner in such a case has to run at any one of the synchronous speeds corresponding to the frequency at which the electric power is supplied. In a 50 Hertz system (50 cycles per second), which is the standard in India, the synchronous speed of the turbine runner, in terms of revolutions per minute (rpm), is 6000/No. of salient poles in the generator. The choice of a suitable turbine runner for a given head would, therefore, depend on obtaining a high enough synchronous speed consistent with such desirable features as high efficiency and depth of submergence of the runner. It would also be apparent from the range of specific speeds that can be obtained (given above) that Pelton turbines are suitable for high heads, Francis for medium heads and Kaplan and axial-flow turbines, for low heads. With axial-flow turbines, the minimum head requirement for economical generation can be lowered further.

Besides the specific speed, two more speeds are associated with the turbine. These are the overspeed and the runaway speed. Overspeed is the speed attained by the generating set when the load on the set is suddenly thrown off. In this condition, the water to the turbine cannot be cut off too quickly for it would result in unacceptable pressure rises in the upstream penstock (the pipe carrying the water from the reservoir to the turbine at a high pressure). In order to limit the pressure rise to a safe value, the water has to be cut off gradually, allowing the set to speed up in the meantime. The speed that will be finally attained is the overspeed of the set. Its value depends on the closing time of the governor regulating turbine speeds (which, in turn, is dictated by the pressure rise limit) and the inertia of the rotating system. Hydro generators are built with high inertia in order to limit this speed rise. Known also as the flywheel effect, this inertia is mainly contributed by the generator rotor; in fact, in medium and large capacity units, the generator rotor accounts for 95 to 97 per cent of the total inertia of the set. The flywheel effect is the summation of the weight of a rotor element multiplied by the square of the radius of gyration of this element. It is apparent, therefore, that for the same flywheel effect, a large diameter of the rotor reduces the weight of the rotor.

The runaway speed is the speed attained by the set in an abnormal condition, when the control mechanism has failed at the time of full load throw-off and the set has speeded up to a level when all the power is now absorbed within the unit itself by increase in losses. Though this is an extremely rare phenomenon, the rotating parts are designed to withstand such a condition for a short time (two minutes as per many international codes).

A large flywheel effect also helps in synchronising the unit with the grid or in regulating the set when a unit is feeding an isolated system.

M.V.P.

substantial savings they afford in civil works which account for the major cost of a hydro installation. In a typical installation, for instance, the civil works cost 70 to 80 per cent of the total. The elimination of the complicated spiral casing, the shorter length of the water path and the lower depth of excavation are some of the major factors contributing to cost savings in axial-flow turbines. The higher specific speeds (see box above) obtained in axial-flow turbines are another point in their favour.

There are, however, some difficulties in coupling the generator to the axial-flow turbine. Many ingenious solutions have also been evolved in the coupling arrangement. These are considered as sub-types of axial-flow units, though some hold them as a different class of units.

Types of axial-flow unit

Axial-flow units come in three types. The most popular is the bulb unit (Figs. 6 and 7). In this type, the generator is enclosed in a stream-lined bulb-shaped shell, placed directly in the water path. The water flows around the bulb. The bulb is usually upstream with respect to the turbine runner, though there are some downstream versions as well.

In the tubular unit (Figs. 8 and 9), the generator is placed outside the water path, except the turbine bearing. A system of gear train may also be used to reduce the size of the generator.

The third arrangement is the rim-type unit, also known as straight flow or straflo-type unit (Figs. 10 and 11). Here, the generator is placed around the turbine. The turbine runner blades themselves serve as the spokes of the rim to which the generator poles are attached. The stator surrounds the rotor.

What are the relative merits of these units? The bulb type is a compact unit. The turbine and generator are overhung. The water-sealing (protective aspects of preventing water from entering the generator elements) is on a relatively small diameter comparable to conventional units, and hence does not pose any special problems. But access to the generator, which is enclosed in a shell, is difficult, though the turbine is more accessible than in the vertical-axis units. The access to the generator is provided through a narrow streamlined vertical passage at the top, which is also used for terminals.

As the conical transition from the bulb to the turbine runner diameter creates flow problems, the maximum bulb diameter is usually restricted to 20 per cent larger than the turbine runner diameter. Beyond this relation, construction becomes expensive. The turbine runner diameter itself has to be kept low; the diameters are related to the head available. The distribution of pressure and velocity over the runner will not be uniform, more so with larger diameters. The region above the axis is prone to cavitation.

These restraints limit the size of the bulb unit. The largest built so far is a 54 MW unit at the Rock Island plant in the USA; it has a runner diameter of 7·4 metres for a rated water head of 12 metres. Another 47 MW unit has been built at the Volga River plant in the USSR; it has a runner diameter of 7·5 metres for a design head of 15 metres. The particulars of some important axial-flow turbine units are given in Table 1.

The generator output can be expressed as KD^2Ln, where D is the diameter of the stator bore, L is the length

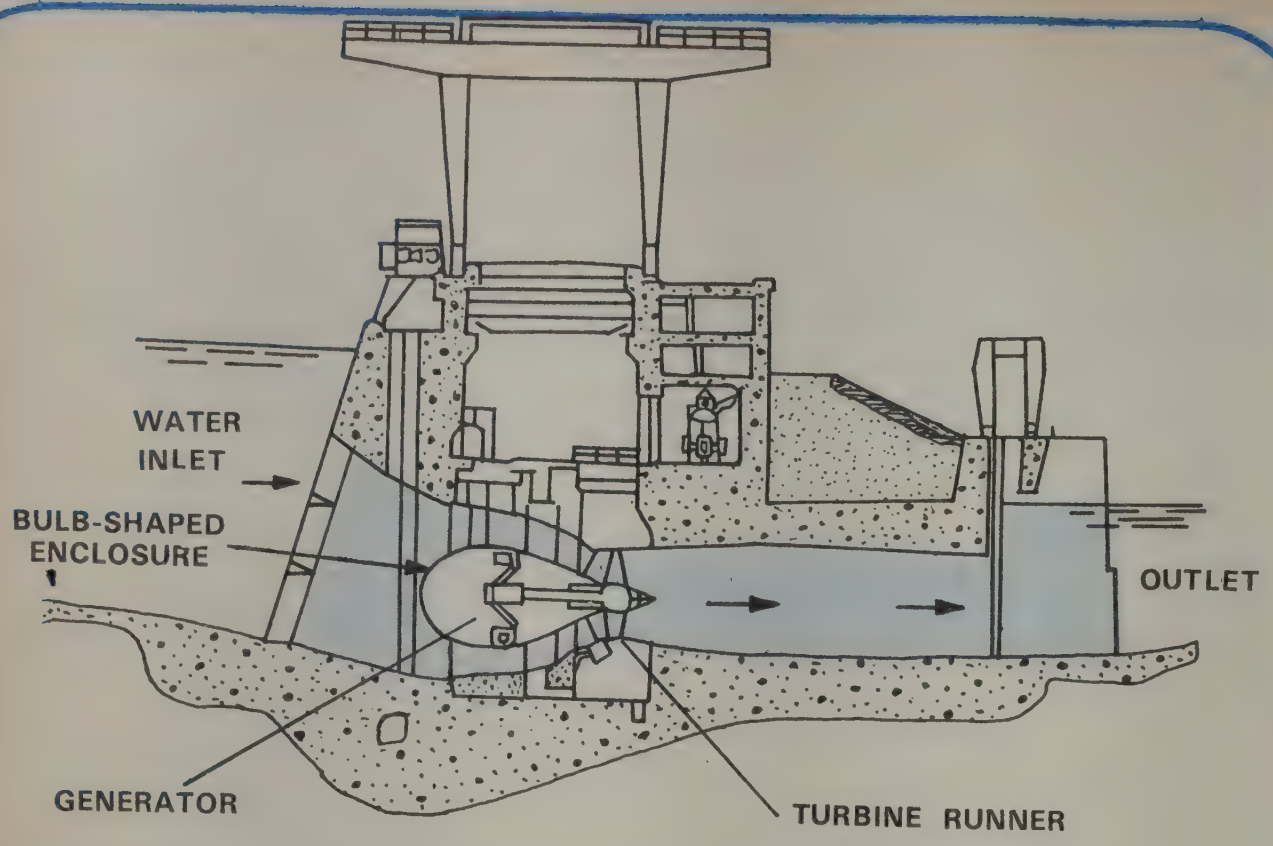


Fig. 6 The bulb unit. The generator is kept in a bulb-shaped enclosure placed in the path of the water flow. Since the generator is enclosed in the bulb, it restricts the generator diameter. This, in turn, restricts the amount of the flywheel effect (see box on p. 17). The flywheel effect is also expressed in terms of the inertia constant, defined as the amount of energy stored in a rotor at a rated speed per kVA rating of the machine and is expressed in terms of kW-secs/kVA. For bulb units, this is 0·7 to 1·1 kW-secs/kVA. (For a conventional generator, it is 2·0 to 5·0 kW-secs/kVA.) If the flywheel effect is low, it will be relatively difficult to synchronise the generator set with the grid. An automatic synchronising equipment can, however, do the job quite well. If the unit is supplying an isolated load, it may have to be de-rated to contain fluctuations within acceptable limits.

Restriction on the generator diameter may also result in higher transient reactance compared to a conventional design. If the pole pitch is too small to necessitate bevelling of the field winding, it would restrict the machine to carry reactive kVAr.

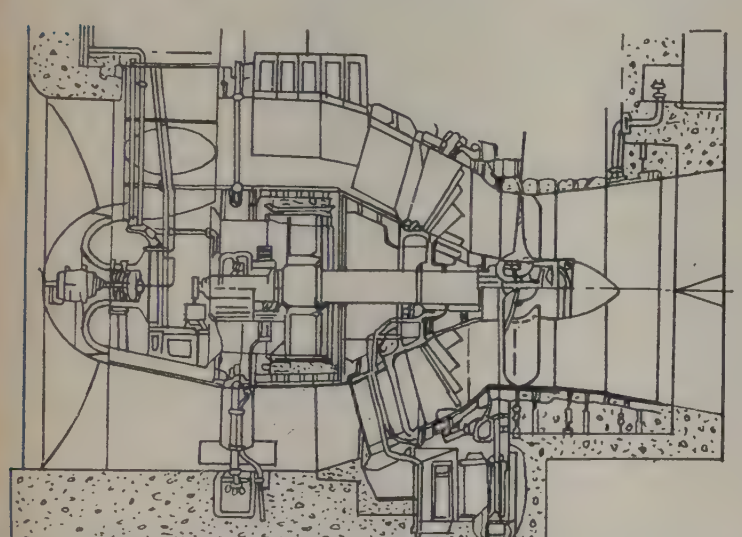


Fig. 7 (Left) The section through the bulb unit

of the stator core, n is the rotational speed, and K a constant depending on the electric and magnetic characteristics of the loadings in the material used. For efficient cooling, the length of the core has to be kept low. With all these restrictions, an efficient generator can still be built using superior materials and methods which can permit higher magnetic and electric loadings. With advances in materials technology, it is now possible to use superior materials. For instance, cold-reduced, low-loss silicon steel permits higher magnetic loading, and epoxy-based insulation systems permit higher current densities.

Many cooling arrangements have also been tried. In one method, hot air from the generator is directed along the inside of the bulb shell. Fins are welded on the shell from inside to increase effectiveness. The water flowing over the bulb carries the heat away. A separate fan forces cooled air through the generator. This arrangement is, however, restricted to sizes up to 10 MVA (mega volts ampere). For larger units, the conventional air-water heat exchangers are used. These exchangers serve as intermediate units; a water pump circulates the heated water through passages provided on the inside of the bulb shell so that the heat is finally carried away by the water flowing over the bulb.

The integrated approach to the design and construction of a bulb unit demands a closer interaction between the generator and turbine manufacturers. For conventional units, it is quite common for the turbine to be made by a manufacturer in one country, the generator by another manufacturer in another country, and to be assembled together only at the site, which may be in a third country. In India, fortunately, Bharat Heavy Electricals Ltd (BHEL) manufac-

tures both water turbines and hy
generators under the same roof.

The tubular u
combines the easy accessibility of
axial-flow turbine with the e
accessibility of the generator as
conventional units. The generator
placed outside the water path. T
inevitably introduces a bend in
water circuit (see Fig. 8). Sometim
the shaft has to be at an inclined a
The turbine bearing housing is
only static part in the water pa
The use of the gear reduces the eff
ency of the unit, though it means
use of a small standardised genera
and excitor. It is essentially an adap
tion of the conventional design.

The tubular unit is costlier th
the other two types. One of the cos
components is the long shaft conne
ing the turbine and the generat
(it is a likely cause of vibration pr
blems). A separate superstructure
the generator pushes up the c
further. However, since the generat
is in the open, it does not suffer fro
the limitations of the bulb unit. T
tubular unit has been installed at t
Ozark Power Station in the US
Each unit is rated at 24·8 MW with
turbine runner diameter of eig
metres.

In the rim-type unit, the sha
interconnecting the turbine and th
generator is eliminated. As mentione
earlier, the turbine runner blade
themselves serve as the spokes of th
rim to which the generator poles ar
attached. This gives a most compac
design. Both the turbine and genera
tor are easily accessible; this facilitate
installation and maintenance. Th
generator design can be optimise
with no constraints on the diamete
and inertia (see box on p. 17).

However, the need to water-sea
a large diameter poses quite a few
problems. The rim and the turbine
runner joint is also complicated, espe-
cially if the runner blade pitch is
adjustable. The problems involved in
sealing and providing adjustable pitch
runner blades have, in fact, delayed
the use of this type on a large scale.
But some of the recent innovations
(see Fig. 10) in these areas are likely
to gain wider acceptance.

Cost comparisons

How do costs of
power generation compare? Compari-
son may be of two types — one,
between alternative sources of energy
as a part of the feasibility study, and
the other, between different types of
turbines and other generating equip-
ment after the site has been finalised.

For either, the cost per kW is usually taken as an index. One has to be aware, however, of the factors that have been taken into account in arriving at the given figure. For example, in a thermal station, the investment needed to open a new coal mine or to strengthen the railway tracks for carrying coal may not be included in the capital cost, and may appear only as running cost of the fuel. Comparing such a figure with the capital cost of a hydro station, where investments by different agencies are not reckoned as running cost of water but as capital cost, may not present a correct picture.

In a multipurpose project like a power-cum-irrigation scheme, the capital costs apportioned to power can be varied to support any point of view. The efficiency of the equipment may also be taken into account. According to one authority, a one per cent increase in efficiency is equivalent to a ten per cent reduction in the equipment cost. Besides, there is a method in which losses in the machine are capitalised according to a certain norm for comparing capital costs. Thus, the cost per kW, without considering the factors assumed in arriving at the figure, can be misleading. And, in many cases, alternative sources of energy may not be meaningful. Thermal and hydro power are often complementary rather than rivals. It is more economical to run thermal stations at full rated capacity on base load and to meet the varying peak demand by hydro power.

Let us compare the costs for low-head hydro installations between the Kaplan and the axial-flow turbines. Though here also the comparison differs with location, three cost investigations made by three different countries and manufacturers indicate the general trend.

The Austrian Danube Power Plant Company compared the costs of 6 vertical units, each rated 31·5 MVA and 75 rpm (revolutions per minute), and 9 axial units, each rated 21 MVA and 100 rpm, for the Ottenshiem

TABLE I. SOME IMPORTANT AXIAL TURBINE INSTALLATIONS

Name of power station	Design head (metres)	Runner diameter (metres)	Capacity in MW	No. of units	Speed (rpm)	Type
AUSTRIA						
Ottenshiem	9·20	5·6	21	9	100	Bulb
Ahenworth	13·6	6·0	38	9	103·4	,,
CANADA						
Jenpeg	7·3	6·25	21	8	81·8	,,
FRANCE						
La Rance	5·8	5·35	10	24	93·8	,,
Beaucaire	10·7	6·25	35	6	93·8	,,
Strasbourg	10·7	5·6	24·5	6	100	,,
Gambsheim	10·35	5·6	24	4	100	,,
GERMANY						
Iffezheim	11·7	5·8	27	4	100	,,
INDIA						
Gandak	6·1	4·5	5·5	3	107	,,
Kosi	7·7	4·5	5·0	4	93·8	,,
KOREA						
Paldong	11·8	5·2	21	4	120	,,
ROMANIA						
Portes de Fer	6·9	7·25	22·8	9	71·5	,,
SWEDEN						
Skogsforsen	14·0	2·18	3·6	1	250	,,
Lovon	13·8	4·5	19·8	2	136·4	,,
SWITZERLAND						
Flumenthol	7·5	4·2	8	3	107	,,
USA						
Rock Island	12·1	7·4	54	8	85·7	,,
Ozark	7·9	8·0	24·8	5	60/514	Tubular
USSR						
Kiev	7·7	6·0	23	20	85·7	Bulb
Volga (Saratov)	10·6/15	7·5	47·3	2	75	,,

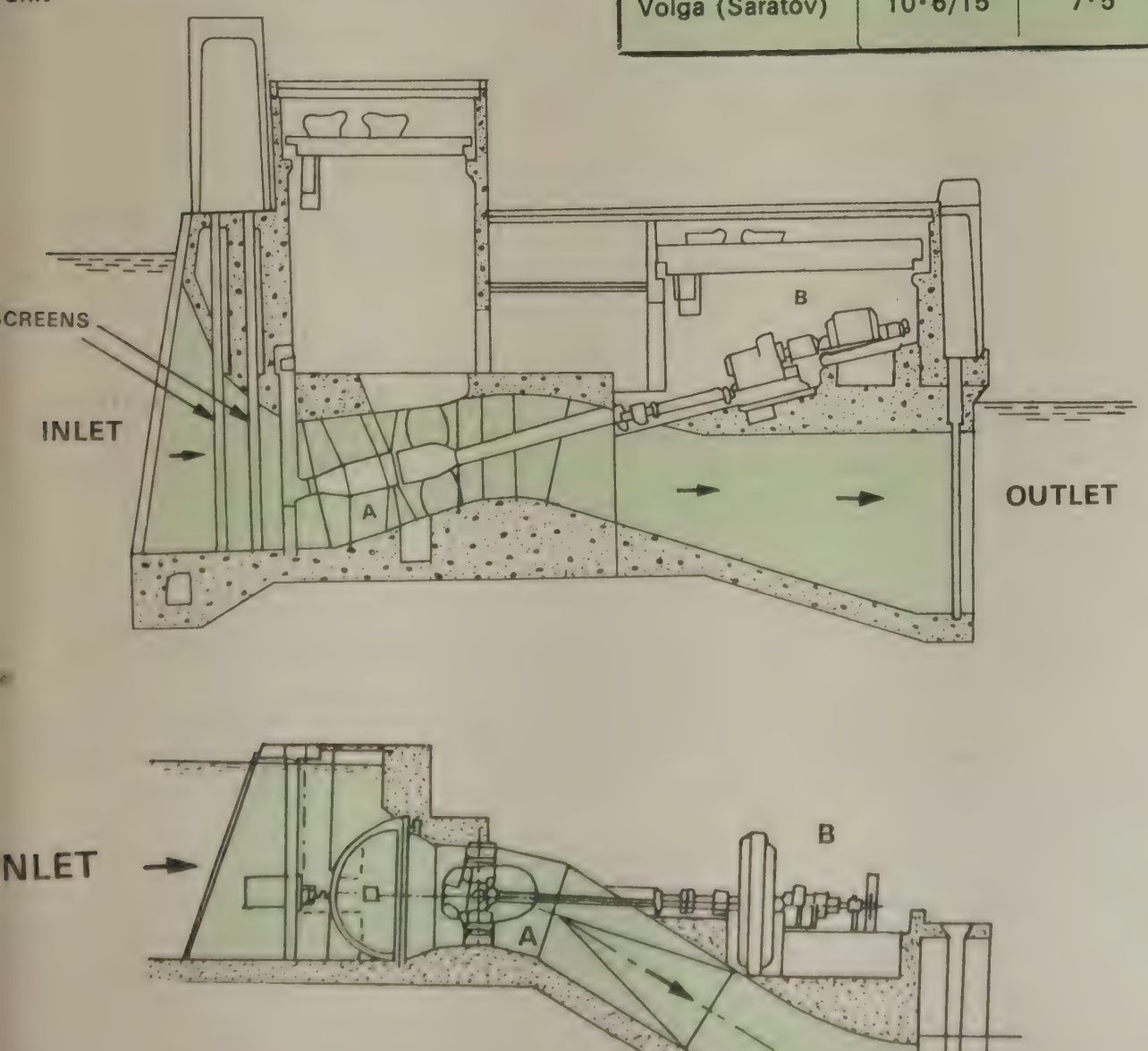


Fig. 8 (Below) The tubular unit. A is the turbine unit and B is the generator unit which is housed separately outside the water path. A long shaft connects the turbine and the generator at an inclined axis. The long shaft and the separate superstructure push up the cost of the tubular unit

Fig. 9 (Bottom) Another arrangement of the tubular turbine. A—turbine unit, B—generator unit

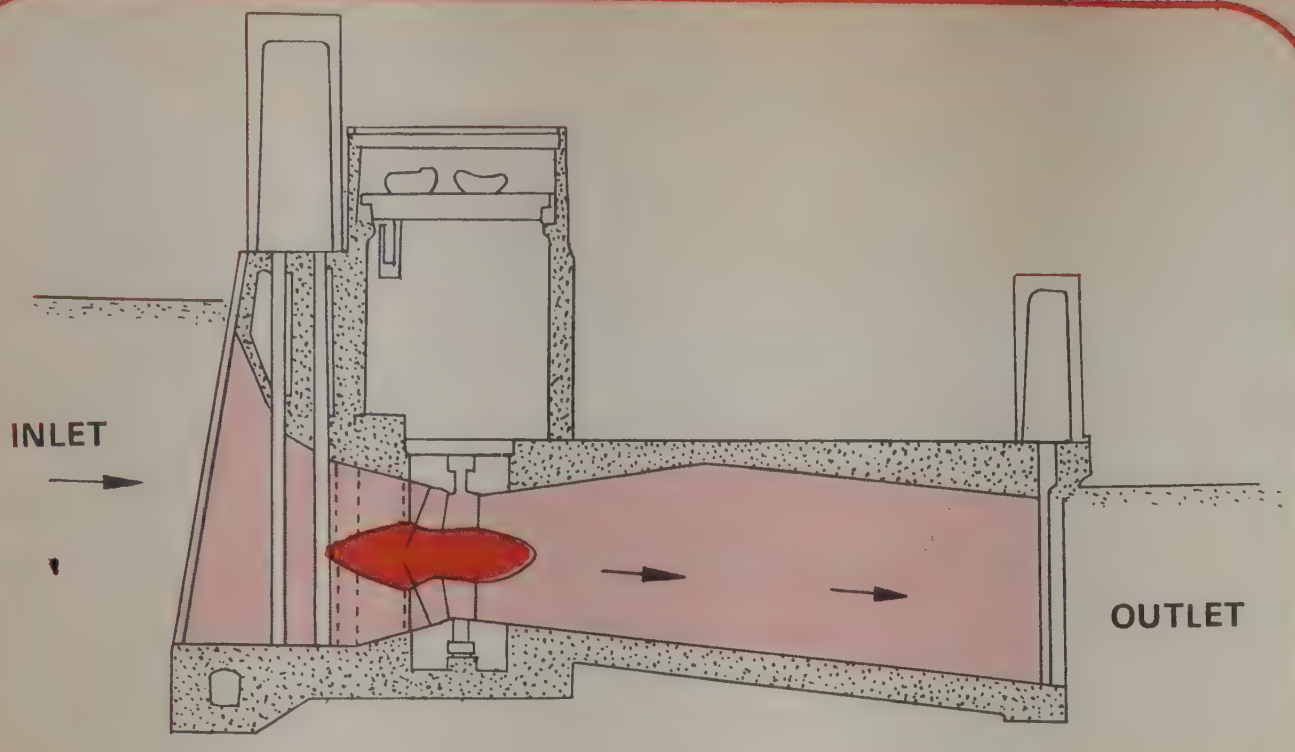


Fig. 10 The straight flow or the rim-type axial-flow unit. It eliminates the shaft interconnecting the turbine and the generator. The generator is housed around the turbine and the turbine runner blades themselves serve as the spokes of the rim to which the generator poles are attached.

Although conceptually a neat solution, difficulties in water-sealing and in providing adjustable pitch runner blades have delayed the use of rim-type units on a large scale. The problems in sealing include the large diameters, high peripheral speeds, large displacement of rotating parts due to elastic deformation, unevenness in a large sealing surface and silt content in water. Severe leakages have been reported in the earlier units. Some of the seals had a useful life of hardly 1,000 hours. The seals have now been improved and have a life expectancy of about 20,000 hours. Escher Wyss of Switzerland, who are the pioneers in such type of units, have introduced hydrostatic seals. The sealing elements are pressed hydraulically against the rotating surface with a constant preset force. Each element has pockets on the side facing the rotating surface. These pockets are pressurised by clean water at a pressure greater than that of the turbine water. A definite leakage of clean water is allowed from these pockets. If the pocket gap is small, the pressure rises in the pocket, forcing the element away from the rotor and if the gap is large, the pressure drops and the turbine water pressure pushes the seal towards the rotor. As there is no physical contact of the seal with the rotating member, high peripheral velocities pose no problem. Elastic deformation of rotor or manufacturing tolerances have no adverse effect on the sealing.

Escher Wyss have also introduced adjustable pitch runner vanes by adopting floating outer bearings. The turbine runner and the generator rim are independent as far as elastic deformation due to rotation is concerned. The bearing permits movement of the rim still maintaining concentricity with respect to the runner.

Besides the problem of sealing, the bearings in the water path have to be designed to bear the loads of both the turbine runner and the generator rotor. The supports and stiffeners of these bearings cause hydraulic disturbances. The turbine runner vanes must also share the weight of the generator rotor with reversal of stresses in addition to the torque transmitted. In certain designs, the centrifugal force due to the rim and poles is also added.

When a directly driven rotating exciter is used, it is placed in an enclosure within the water passage.

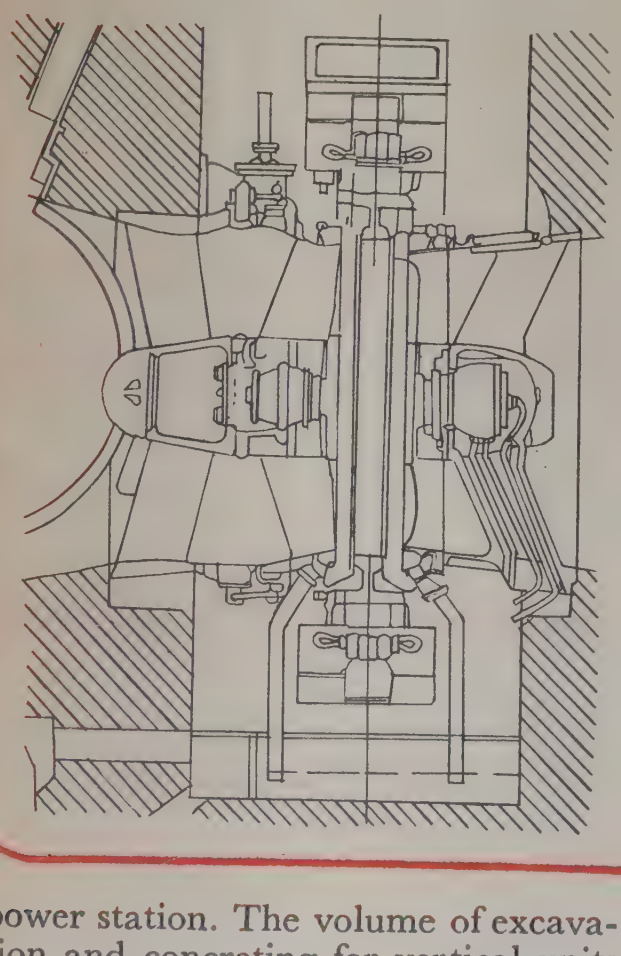


Fig. 11 (Left) Section through the rim-type unit

power station. The volume of excavation and concreting for vertical units were 1·24 times that of the axial units. Erection costs for the bulb-type generators also came to 85 per cent that of vertical units. The peak efficiency of the bulb units was 1 to 2 per cent higher and it had more uniform head variations compared to the vertical type. The cost per kW was about 1·5 to 2 per cent lower for the bulb-type unit.

In an in-depth study of axial
for the La Rance Tidal Sch
Electricite de France (EDF) est
ted a saving of 25 per cent in
works and 15 per cent in the total
compared to Kaplan turbines. A
flow units also gave better efficie
than Kaplan units.

The Skogsforsen power statio
Sweden had Kaplan units. W
expansion was planned, electri
authorities studied the cost for e
ing Kaplan units, a much sim
fied horizontal Francis unit
a bulb-type axial unit. They fo
that the bulb unit was the m
advantageous, both in capital
and efficiency. They expanded
station in 1969 by installing b
units.

These examples, however, sh
that the cost-benefit in the axial-t
units can be realised only when
project is taken as a whole. If only
generating equipment (the turb
and the generator) is considered,
cost per kW for axial-flow units m
be even higher. This is so because
optimum unit size for the axial turb
is smaller, and the placing of
generator, either in a bulb or at
rim of the turbine runner, is expensi
However, unlike conventional ge
rators, axial units are amenable
greater benefit of scale. The init
sets may be costly but the cost w
come down considerably once
technology is developed indigenous
There is indeed a good case for buil
ing up this capability in the countr

Axial-flow turbines can be bu
with movable or fixed guide van
with movable or fixed runner blade
Any combination is possible. Movab
vanes and runner blades afford bett
regulation and higher efficiency, b
they also cost more. Fixed guid
vanes and runner blades are only use
in small capacity sets.

There are indeed any number
permutations and combinations poss
ble, and every site would require i
own cost analysis. However, on
general observation can be safel
made: that axial-flow turbines offe
an attractive alternative for low-hea
hydro power installation.

Mr. Pandit (47) i
senior manager a
Bharat Heavy Elec
tricals Limited, Bho
pal, in charge o
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graduate in mechani
cal and electrica
engineering from
Bombay University, he specialised in th
design of hydro generators at the Associate
Electrical Industries in the UK.

HYSICS

Was It a Magnetic Monopole?

A MAGNETIC monopole is the magnetic counterpart of an electron. P. A. M. Dirac, the Nobel ysicist who predicted the existence the positron, found a lack of nmetry in Maxwell's equations e fundamental equations of electro-gnetism) and, to restore symmetry th respect to electricity and magne-m, he postulated the existence of the gnetic monopole in 1931. Ever ce, attempts have been made to ok for it in ocean sediments, in eteorites, in magnetic iron ores d in Moon rock samples, but in in. However, from these studies, was possible to set lower limits for e mass of the monopole and describe ne of its properties.

Two and a half years ago, ysicists from the USA (P. B. Price d others) reported the observation a track of a particle in a module ntaining plastic sheets and photo-aphic plates) which was flown in a lloon for the detection of ultraheavy smic rays; they ascribed it to the ssage of a magnetic monopole rough the detector stacks. (See IENCE TODAY, October 1975, p. 21). previous attempts, the total effec-e collecting power of particles from ace was a million times more than Price's experiment. Yet, they had led to see even a single particle. ence Price's discovery evoked a lot interest.

Several scientists like Prof. L. W. varez and M. W. Friendlander from e USA and Prof. P. H. Fowler from e UK carefully reanalysed the event d tried to explain it as due to the eak-up of a cosmic ray platinum cleus.

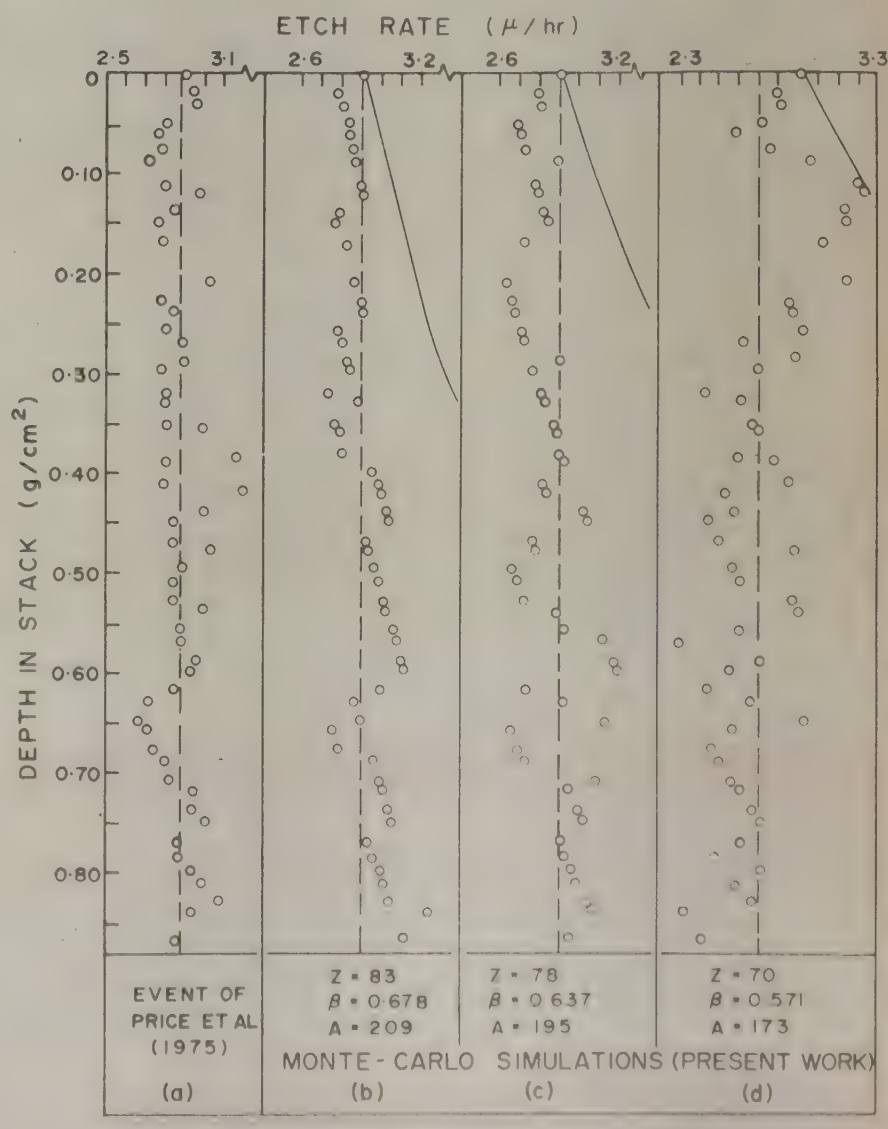
Recently, Dr. M. V. S. Rao and yself reanalysed the event in a frame-ork not considered so far by others eported in *Physics News*, June 1977, 76, and in a paper to be published *Pramana*). Cosmic ray particles at w charge values and travelling with locities close to that of light are mpletely stripped of orbital elec-ons. That means they are all nuclei ithout any electrons in outer shells. ut when the velocity of the ion comes comparable to $Zc/137$, where is the charge and c the velocity of ght, the nuclei begin to capture ppreciably) electrons in its passage rough the detector. The frequency ith which such processes occur is etermined by the so-called mean free paths of the nuclei in various media. We studied these two processes of electron capture and stripping in plastic detectors. One of the interesting things we noted was that the average mean free paths for these two processes, for cosmic ray nuclei around platinum and velocity in the range 0·6 to 0·7 c, were of the order of the thickness of plastic sheets used in the experiment. This means that only one stripping or one capture collision on the average would take place in each of the sheets. This is contrary to the normal assumption that several such collisions are taking place in each sheet. In other words, since we make observations on the tracks in each sheet, what we see is a 'snapshot' of these two processes as they were taking place in the detector. We interpret the event as due to a cosmic ray nucleus of charge about 70–80, picking up and losing electrons as it traverses through the plastic detector as explained below.

A charged particle, passing through the plastic stack, loses energy and thereby has an increasing etch rate as it goes to lower depths of the stack. A magnetic monopole, on the other hand, will lose energy at a constant rate and will have a constant etch rate. In the figure shown alongside, we plot this etch rate as it passed through various sheets. In (*a*) are the points obtained by Price which seem to show a constant etch rate as indicated by the dotted line. That is why he interpreted it to be a monopole. By a method called 'Monte-Carlo Simulations', we theoretically obtained the etch rates for various depths assuming three values of incident charge of the nucleus. These points are shown in (*b*), (*c*) and (*d*). The dotted lines are the average values of these points. The solid line indicates how a completely stripped normal cosmic ray nucleus would behave. It is clear from this figure that our theoretically obtained points are scattered around the dotted line and behave in a way similar to what Price and others have obtained. Thus, we conclude that the particle track was most probably due to a cosmic ray nucleus picking up and losing electrons.

What are the possible consequences of such an interpretation? Till now, physicists have attributed charge values in high-energy cosmic rays to the fact that these nuclei are completely stripped and suffer losses mainly due to ionisation. A cosmic ray nucleus passing through the stack should then behave like the solid line seen in the figure. But it does not. It follows the broken line. Thus, the present interpretation will have an impact on the charge estimation of such highly charged and energetic cosmic ray nuclei seen in plastic detectors. Consequently, the relative numbers of various nuclei in cosmic rays would need revision and, in turn, will influence the theory of the origin of ultraheavy cosmic rays and the synthesis of these ultraheavy elements in stars.

N. DURGAPRASAD

[Dr. Durgaprasad is with the Cosmic Ray and Solar Physics Group at the Tata Institute of Fundamental Research, Bombay.]



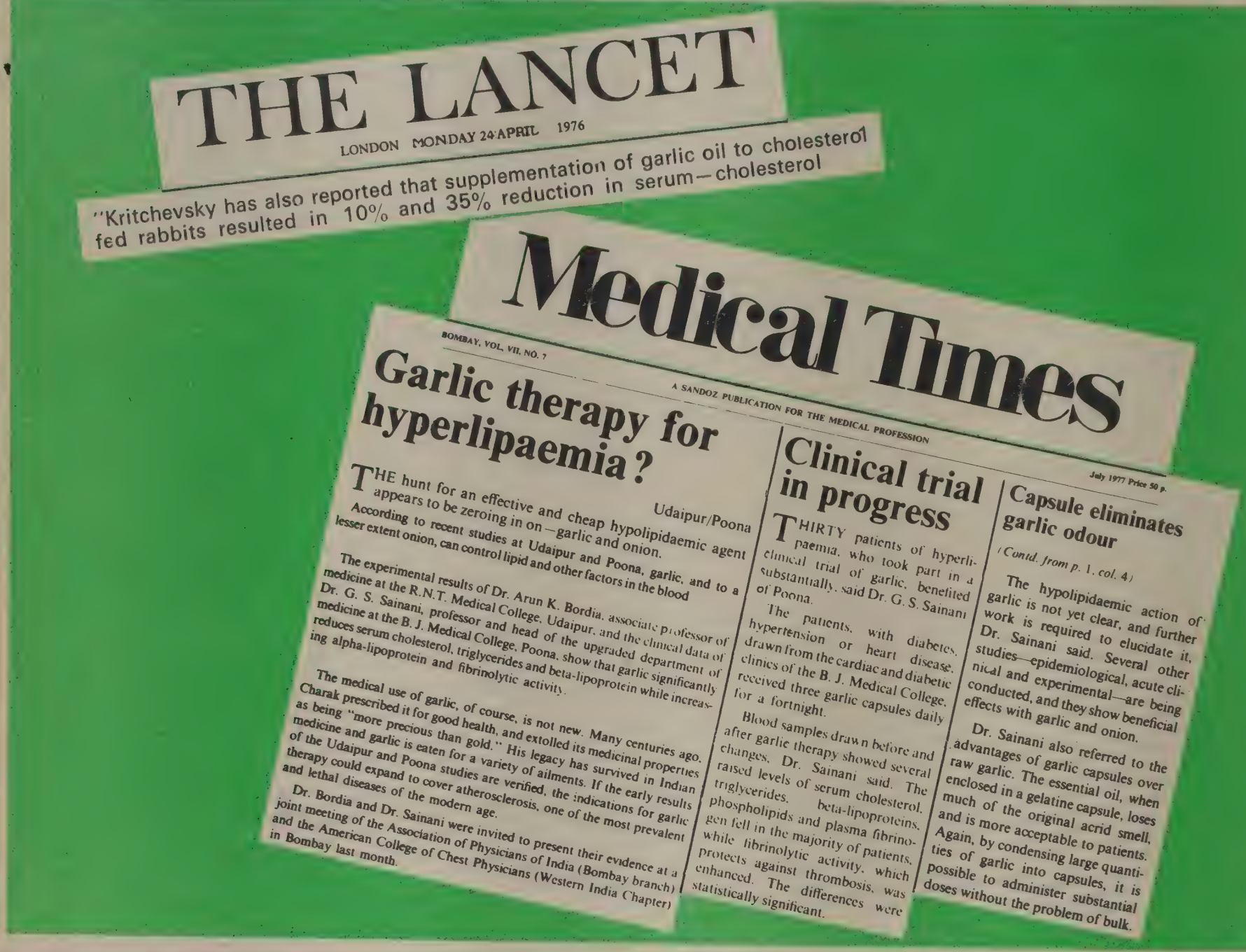
SPECTROSCOPY

Flame Diagnostic Tool

ELECTRONS in atoms, besides rotating around the nucleus, spin about their axes like a top. When the angular momentum, which arises from the spin, gets oriented in a particular direction, the atoms are said to be spin-polarised. It is possible to spin-polarise atoms

NOW, THE MEDICAL PRESS HAILS 'LASUN'

the traditionally well-known ayurvedic herbal remedy



THE LANCET

LONDON MONDAY 24 APRIL 1976

"Kritchevsky has also reported that supplementation of garlic oil to cholesterol fed rabbits resulted in 10% and 35% reduction in serum—cholesterol

Medical Times

BOMBAY, VOL. VII, NO. 7

A SANDOZ PUBLICATION FOR THE MEDICAL PROFESSION

July 1977 Price 50 p.

Garlic therapy for hyperlipaemia?

Udaipur/Poona

THE hunt for an effective and cheap hypolipidaemic agent appears to be zeroing in on—garlic and onion. According to recent studies at Udaipur and Poona, garlic, and to a lesser extent onion, can control lipid and other factors in the blood

The experimental results of Dr. Arun K. Bordia, associate professor of medicine at the R.N.T. Medical College, Udaipur, and the clinical data of Dr. G. S. Sainani, professor and head of the upgraded department of medicine at the B. J. Medical College, Poona, show that garlic significantly reduces serum cholesterol, triglycerides and beta-lipoprotein while increasing alpha-lipoprotein and fibrinolytic activity.

The medical use of garlic, of course, is not new. Many centuries ago, Charak prescribed it for good health, and extolled its medicinal properties as being "more precious than gold." His legacy has survived in Indian medicine and garlic is eaten for a variety of ailments. If the early results of the Udaipur and Poona studies are verified, the indications for garlic therapy could expand to cover atherosclerosis, one of the most prevalent and lethal diseases of the modern age.

Dr. Bordia and Dr. Sainani were invited to present their evidence at a joint meeting of the Association of Physicians of India (Bombay branch) and the American College of Chest Physicians (Western India Chapter) in Bombay last month.

Clinical trial in progress

THIRTY patients of hyperlipaemia, who took part in a clinical trial of garlic, benefited substantially, said Dr. G. S. Sainani of Poona.

The patients, with diabetes, hypertension or heart disease, drawn from the cardiac and diabetic clinics of the B. J. Medical College, received three garlic capsules daily for a fortnight.

Blood samples drawn before and after garlic therapy showed several changes. Dr. Sainani said. The raised levels of serum cholesterol, triglycerides, beta-lipoproteins, phospholipids and plasma fibrinogen fell in the majority of patients, while fibrinolytic activity, which protects against thrombosis, was enhanced. The differences were statistically significant.

Capsule eliminates garlic odour

(Contd. from p. 1, col. 4)

The hypolipidaemic action of garlic is not yet clear, and further work is required to elucidate it, Dr. Sainani said. Several other studies—epidemiological, acute clinical and experimental—are being conducted, and they show beneficial effects with garlic and onion.

Dr. Sainani also referred to the advantages of garlic capsules over raw garlic. The essential oil, when enclosed in a gelatine capsule, loses much of the original acrid smell, and is more acceptable to patients. Again, by condensing large quantities of garlic into capsules, it is possible to administer substantial doses without the problem of bulk.

Professional medical journals, the Lancet from London and Medical Times from Bombay widely read by doctors in India and abroad have reported favourably on the medicinal uses of garlic in effectively reducing cholesterol and for other related diseases. After conducting clinical trials which are still continuing, we at Thomas Pharmaceuticals, are able to offer you the benefits of this amazing and traditionally well known ayurvedic herbal remedy, after completely eliminating its offensive odour. The active principle of garlic which is carefully extracted from garlic pods, is now presented in a scientifically measured-dosage, odourless Lasona capsule without sacrificing garlic's intrinsic qualities.

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pioneers in garlic therapy

by external means. One such method is optical pumping which came into prominence along with the laser. In this method, the electrons are pumped into certain preferred higher energy levels in the atoms. The return of such electrons to ground levels leads to emission of a laser radiation of a particular frequency. Lasers, in turn, can be used to achieve optical pumping.

Spin polarisation effects in atoms through optical pumping have been studied in the past, especially by using homogeneous samples of atoms. A team of workers from the Columbia Radiation Laboratory of the Columbia University, USA, has reported the observation of spin polarisation of sodium atoms in hydrocarbon flames by this technique, and that too at atmospheric pressure. (*Physical Review Letters*, **40,** No. 1, January 1978.) S. M. Cuny and co-workers claim it to be the first observation of its kind. The authors also report the observation of radio frequency magnetic resonance transitions in an optically pumped flame. These observations are significant because the combustion processes in flames are of great interest.

In their experiment, the authors used a circularly polarised light from a 160 mW cw dye laser. This light at sodium D wavelength (5896 Å) helped to produce spin polarisation of ground-state sodium atoms in hydrocarbon flames. A sodium chloride-coated stainless-steel mesh at the exit orifice of the burner provided the sodium atoms in the flame. The spin relaxation rate, or the time for which the atom remains in the excited state, at different points in the flame were measured by the Hanle effect technique. In this technique, the fluorescence signal from the spot in the flame where the laser beam is focused is observed by applying a perpendicular magnetic field which is varied from negative to positive magnitude. Actually, the transverse magnetic field tries to diminish the spin polarisation. This leads to more absorption of laser light and hence more fluorescence. The Hanle signal is a minimum fluorescence at zero field. The spin relaxation rate is determined from the shape of this signal after accounting for the power broadening. The spin relaxation rate is a measure for the spin-exchange collisions and chemical reactions of the sodium atoms with other atoms or molecules and so indicates the local composition of the flame.

Different gas mixtures like methane-ethane-oxygen, propane-oxygen and hydrogen-oxygen were used for the flames. Simultaneously, flame temperatures at various points were estimated with a platinel thermocouple which showed correlation with the relaxation rate. The relaxation times in the flame were found in the range of 0·5 microsecond to 40 nanoseconds.

The authors also observed strong rf magnetic resonance signals of spin-polarised optically pumped sodium atoms in the propane flame. In this case, the magnetic field was applied parallel to the laser beam and an additional rf field at 12·05 MHz was applied perpendicular to it. The resonance signal was found to have the same shape as the Hanle signal, only it was found at a non-zero magnetic field.

According to the authors, the results obtained open up the possibility of using spin-exchange spectroscopic techniques to study the molecular structures of free radicals or measuring the concentrations of radicals and other constituents in flames.

A. V. SAPRE

[Dr. Sapre is with the Science and Technology Cell, Education Department, Government of Maharashtra.]

TOXICOLOGY

Tetrodotoxin in Octopus Venom

TETRODOTOXIN is unique in many respects. It is one of the most powerful known neurotoxins. Its unusual chemical structure has never before been encountered either in natural substances or those prepared in the laboratory (see SCIENCE TODAY, June 1977, p. 36); and to cap it all, it now transpires that it is also extremely ubiquitous. The chemical has now been found in the salivary gland of the blue-ringed octopus *Hapalochlaena maculosa* by Australian scientists (*Science*, **198,** p. 188, 1978).

Tetrodotoxin was first isolated from one sub-order of fishes, the Tetraodontoidae. But in 1964, it was obtained from the eggs of various species of western American newts of the genus *Taricha;* it is present in adult newts as well as in the eggs and embryos. Its occurrence in two such different animals was surprising because the compound does not seem to be easily derivable from any of the normal biosynthetic pathways. Subsequently, tetrodotoxin has also been isolated from a completely different fish, the goby (*Gobius criniger*) from Taiwan; and recently Stanford University, USA, researchers have identified tetrodotoxin in extracts of skin from three populations of frogs of the genus *Atelopus* from Central America.

The chemical structure of the tetrodotoxin molecule, elucidated in 1964, has several remarkable features. It has a positively charged guanidinium ion balancing a negatively charged hemilactal anion. The unexpected stability of this otherwise unstable hemilactal system in tetrodotoxin is due to a strain-free arrangement of the atoms as in the adamantane molecule. (The adamantane skeleton is the basic three-dimensional repetitive unit of the diamond lattice.) In tetrodotoxin, the two carbon atoms of the adamantane framework have been replaced by oxygen atoms, leading to a dioxa-adamantane.

Tetrodotoxin is about 50 times more toxic than strychnine and nearly 1,000 times more than sodium cyanide. The wide distribution of tetrodotoxin in widely different animals (puffer fish, goby, newts, frogs) suggests that it may have some physiological function besides providing protection from predators. It was suggested that tetrodotoxin might have antimitotic properties similar to those of substances extracted from ovaries of starfish. But this couldn't be proved. Nor could any antibacterial effect of tetrodotoxin be demonstrated. Thus, the physiological functions, if any, are yet to be found.

There could be another probable explanation: tetrodotoxin might not actually be produced in the animals themselves, but might originate in their food. However, it seems quite unlikely that a widely distributed toxic plant or micro-organism that could serve as a food source for all these organisms would have eluded detection till now. The conclusion, therefore, has been that, "it seems more logical to assume that the ability to synthesise tetrodotoxin was a coincidental genetic development in certain fishes and amphibians either because it has survival value or because it is a metabolic end-product that happens to be toxic".

The Australian scientists, D. D. Sheumack, M. E. M. Howden, I. Spence and R. J. Quinn isolated and positively identified tetrodotoxin from extracts of the posterior salivary glands of the blue-ringed octopus. And this is the first time that tetrodotoxin has been found in a venom.

The venom glands of the octopus were homogenised with acetic acid solution and then centrifuged, decanted, frozen and dried. The residue was extracted with pure acetic acid four times and concentrated to 100 ml. The concentrate was filtered by dialysis at a constant volume with 1 litre of acetic acid. The filtrate, containing the toxin, was dissolved in 0·1 M

(Contd. on p. 58)

what starlight tells us about stars

AJIT KEMBHAVI

THE stars are at enormous distances from us. The nearest, Proxima Centauri, is about 4·2 light ars away. Because of their moteness, except for the Sun, ere is no star that can be apoached closely by any known acecraft, now or in the foreseele future. Hence anything we ow about stars, all information out the world outside the solar stem, is gleaned from two urces — starlight, and cosmic ys. Most of what we know obtained from the first source nce we still aren't certain where e cosmic rays come from. We ll see how astronomers analyse e light from stars to obtain a rprising amount of data about em.

Why do stars emit light? This estion has been answered by anysing the stars' *spectrum*. Most ars are so hot that the matter them is in gaseous form. At e surface of a star like the Sun, e temperature is typically veral thousand degrees Kelvin, d it steadily increases towards e interior. Deep inside, the temerature is around 10 million egrees or even more. This is here the nuclear reactions which roduce the star's energy take ace. The energy radiation proced here slowly travels to the rface, passing from atom to om, until it reaches the surface yer known as the *photosphere*, om where it can escape into pace. The Sun's photosphere is bout 320 km deep. Comparing is depth with the radius of the un (about 7,00,000 km), it is vident that light coming to us om a typical star like the Sun nveys direct information about nly a small fraction of its total ntents.

The temperatures in the varius levels of a star are so high hat, except in the outer layers of ome of the cooler stars, chemical ompounds or even simple molecules cannot exist. The gases of he star are, therefore, in the tomic state and it is these atoms hat emit the radiation which eaches us as starlight. Atoms mit photons, and each photon of adiation is unmistakably stamped with the mark of its origin in he 'energy levels' of the atom. y examining these photons we an infer something about the toms and their environment.

As is well known, he atoms of a given element can xist in any one of a number of

Fig. 1 Most likely a star is made up of several concentric spherical layers, each with different properties. The temperature of the interior increases as the centre of the star is approached reaching over ten million degrees in the central core. This region is a thermonuclear reactor. The only layer we can observe directly is the outermost one — the photosphere. The temperature here is about 6000 C, cool enough for atoms to exist as atoms. Photons emitted by these atoms tell us about the chemical constitution of the photospheric layer of the star. The characteristics of the inner layers have to be inferred from theoretical analysis, since they cannot be directly observed

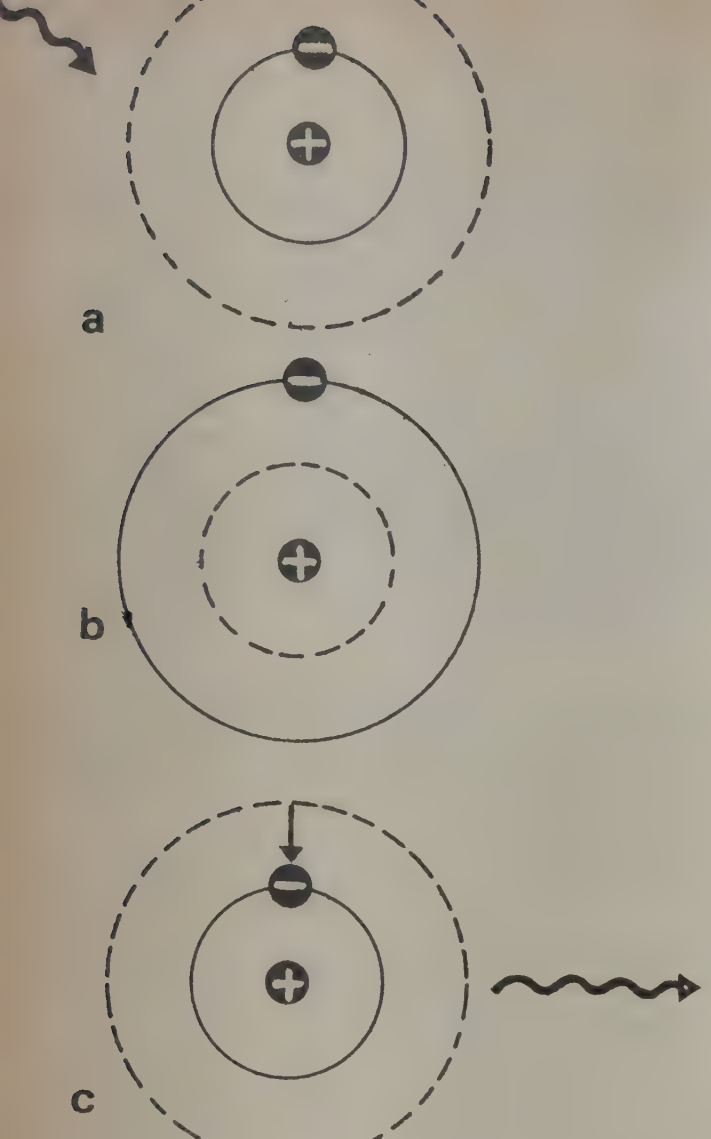


Fig. 2 (*a*) An atom can be excited to a state of higher energy by absorbing energy in the form of an incoming photon, depicted in the figure by a wavy line. (*b*) The electron simultaneously jumps from an orbit of lower energy to one of higher energy. (*c*) On de-excitation, the electron jumps back, and a photon of energy is emitted

discrete energy levels, of which the level of lowest energy is known as the ground state. An atom usually rests in its ground state, but it can be excited to higher energy levels by absorbing energy from external radiation or by colliding with other atoms. Both these processes are expected to take place inside the stellar gas.

The atom doesn't remain in its excited state for long. It makes a transition to a lower energy level either spontaneously or upon being de-excited by some external disturbance. The energy difference is not lost, of course. It is emitted in the form of a photon whose frequency (colour) is proportional to its energy. Photons from the stars, therefore, can come in a whole range of frequencies, depending on the physical processes that produced them, or modified them, en route to us.

To the naked eye, one star looks much like another — some brighter than others. Colour differences, though noticeable, are almost imperceptible. But when the light from each star is passed through a prism (as Newton did with the Sun's light), its individuality becomes obvious. The light is dispersed into a band of various component frequencies known as the *stellar spectrum*. Further measurements on this spectrum tell us in what amounts the photons are received (the 'intensity') and in what colours. And each type of star has its own signature of photons. The instrument used for this is known as a spectrograph — which is but a sophisticated descendant of Newton's primitive prism and screen.

More about spectra

The spectrum of a typical star appears as a continuous band of colours, known as the *continuous* spectrum, on which are superimposed dark lines (see Fig. 6). The systems of dark lines were first studied by the German physicist Fraunhofer in 1814–15, and are known as the *absorption* spectrum of the star. Let us see how these two components of the spectrum occur.

The continuous spectrum is produced when an ion 'de-ionises'. In the hot interior of the star, atoms are excited to such a degree that many lose one or more electrons to form ions. Now, when an excited atom de-excites, its electrons jump into configurations of lower energy and a photon is emitted. Similarly, the capture of a passing electron by an ion is also accompanied by the emission of a photon. These photons come in a whole range of frequencies which are so closely spaced that they cannot be resolved into lines by the spectrograph and hence appear as a continuous spectrum.

As this stream of photons from the interior passes through the photosphere, certain photons are removed from the mainstream. These are just those that are absorbed by the atoms present in the photosphere. Their frequencies correspond precisely to the differences in the energy levels of these atoms. Of course, they are re-emitted when the atoms de-exite, but generally in a different direction (Fig. 4). The mainstream is thus depleted of photons of these frequencies. In a spectrograph this depletion shows up as relatively dark lines and superimposed on the brighter tinuous spectrum. Hence the 'absorption spectrum'.

In the spectrum of some galaxies, quasars and emission lae, there also appear a series of b lines. These form the *emission* trum. These lines are a little complicated to explain. In ga nebulae for example, it is beli that the lines are due to emis from atoms which have been ex by the energy released in gravitat contraction.

It has become known comparat recently that stars emit in all reg of the electromagnetic spectr Much information about their st ture can be had by studying gamma rays, X-rays, ultraviolet infrared radiation and radio w coming from them. We will, howe not go into these topics, and st only the message contained in *visual* radiation from the stars.

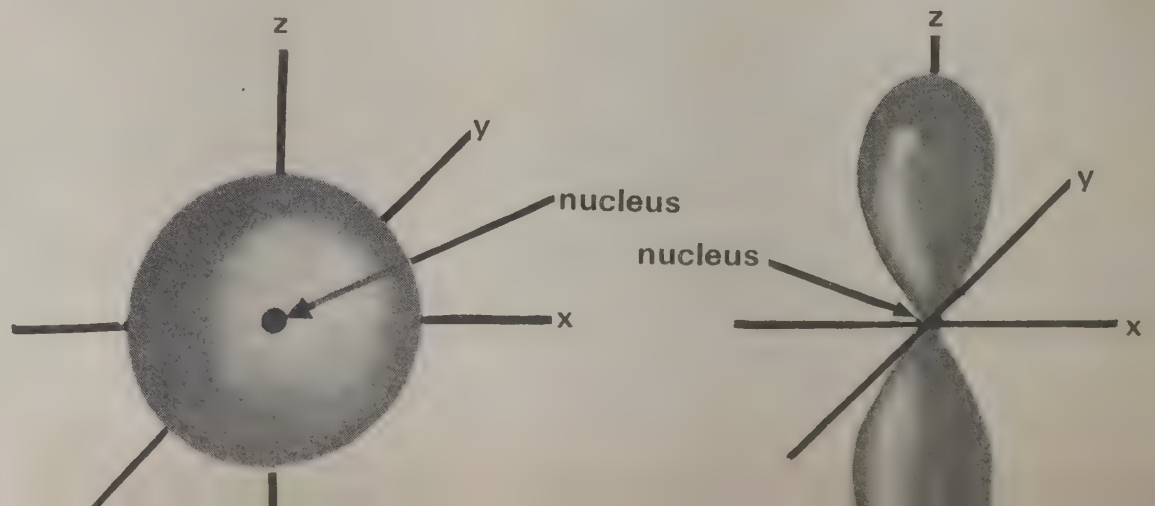
What would we like to know ab stars? There is no limit to the gree the curious: what are they made (their composition)? How far are t from us (their distance)? How they come to be (their origin history)? What's happening in them? Are they moving? Rotati How big are they (size and mas Do they have planets? Is there biochemistry taking place on stars? Biology? Any question that ask about the solar system and planets is a valid scientific quest about stars.

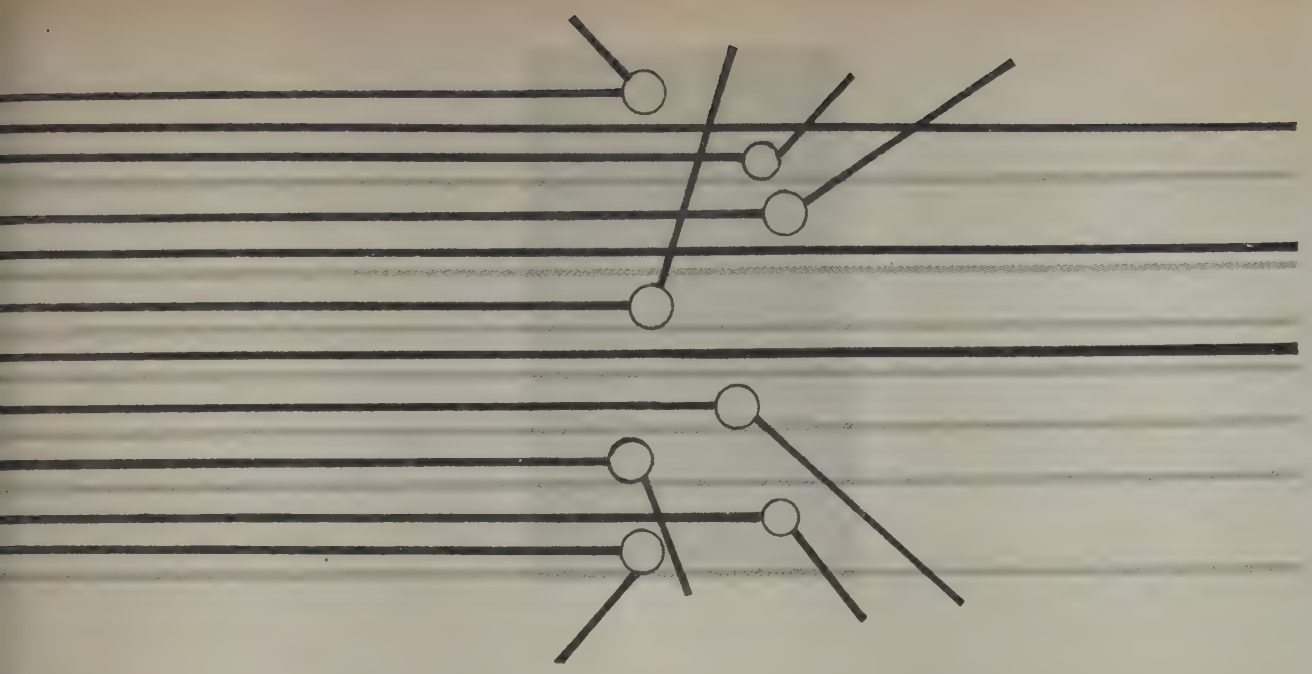
Our present knowledge, howev is in a primitive stage, and we can o answer the first few of these quer that too only tentatively, appro mately.

What are stars made of ?

We have seen that the atoms o given element, when in gaseous for produce a characteristic pattern absorption and emission lines. T presence of lines characteristic of

Fig. 3 Atoms can exist only in certain states with well-defined energies. When an atom make transition from one state to another, its shape changes. The shapes that the hydrogen atom ta in its lowest two energy states are shown here. The shaded areas are the regions (known orbitals) to which the orbiting electron is restricted. Axes are drawn to emphasise the thr dimensionality of each shape





g. 4 An incoming beam of light of two different frequencies is shown impinging on a layer of oms. The atoms can absorb photons of one frequency (indicated by full dark lines). This energy subsequently re-emitted — but in all directions. The beam itself in crossing the layer is depleted this frequency. Such a phenomenon occurs when light traverses the star's photospheric layer, d causes the dark lines in the absorption spectrum

ertain element in the spectrum of a eam of light means that atoms of the ement are present somewhere along ie path taken by the light. The study f the absorption and emission spectra f a star can, therefore, lead to the lentification of the elements present i its outer layer.

The detailed nature of the spectrum lso depends upon physical conditions ke the temperature and pressure revailing in the photosphere. For xample, hydrogen, which is by far ie most abundant element in all the ars, can produce absorption lines nly in the atmosphere of the cooler ars, where it is present in the atomic ate. In the atmospheres of very hot ars, however, it is completely ionised nd can produce only a continuous pectrum.

Atoms emit photons: more atoms ill emit more photons. Therefore, y measuring the *relative strength* of bsorption lines in the spectrum of a tar, after making due allowance for he conditions prevailing in the pho- osphere, we can infer the relative *bundances* of the various chemical lements whose lines appear.

It is found that in a typical star, ydrogen comprises between 50 to 80 er cent of its mass. Hydrogen and elium together constitute 96 to 99 er cent of the mass. (The element elium was first discovered in the un, even before it was known on he Earth, by the presence of absorp- ion lines in the solar spectrum which id not match those due to any known lement on Earth.) Among the 4 per ent or less of heavy elements, neon, xygen, nitrogen, carbon, magnesium, rgon, silicon, sulphur, iron and hlorine are amongst the most abun- lant in the photosphere.

Does life exist around stars? Note hat the existence of elements like arbon, hydrogen, oxygen, nitrogen in stars means that some of the basic components of organic chemistry are present there. Complex organic molecules have recently been identified in the interstellar dust. However, the probability of life existing outside the solar system is still an open question. To answer it, it would be necessary to establish that sufficient conditions for life are present elsewhere in the universe. Research here on earth is well along the way of identifying just what these ' sufficient conditions ' are. It will probably be much more difficult to confirm that a full set of such conditions is present around some star.

How hot are the stars?

All hot bodies emit a certain kind of radiation known as ' black body ' radiation. Readers should not be misled by the name, since this radiation is the cause of the ' red-hot ' colour of a heated metal rod, and the ' white-hot ' colour of an electric bulb when it is turned on. Black body radiation is really a combination of frequencies (colours), with each frequency carrying a characteristic amount of energy. The distribution of energy over each frequency depends only on the overall temperature of the emitter. In fact, the temperature of the emitter can be measured by finding out what frequency carries the maximum energy. This ' peak frequency ' is just proportional to the temperature—a fact which was discovered by Wien.

Now, it is known that light in the continuous spectrum of stars approximately resembles the radiation coming from a black body. The resemblance is not complete, however, for, different layers of the stars are at different temperatures whereas a black body is supposed to be at the same temperature throughout its volume. Moreover, as the stellar radiation passes through the outer layers of the star, different wavelengths are absorbed in different amounts and the spectrum is distorted. In spite of these limitations, it is usually a satisfactory approximation to assume that the radiation emitted by a typical star is equivalent to radiation from a black body with temperature equal to that of the star's photospheric layers.

When starlight is analysed through a spectrograph, and the peak frequency

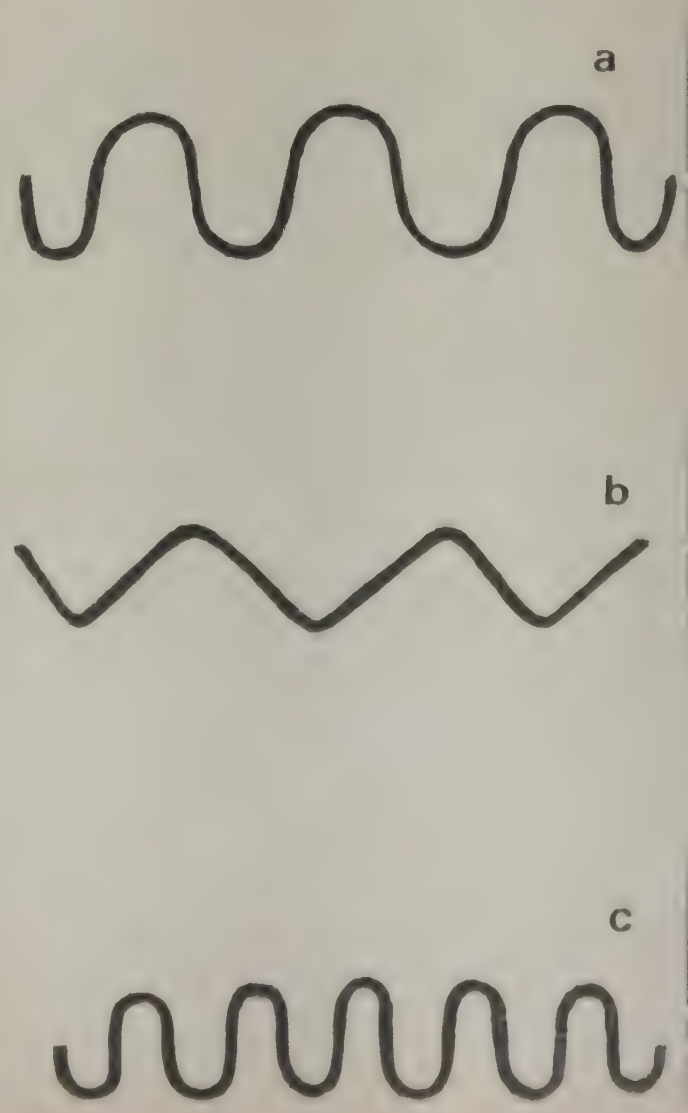


Fig. 5 When a light source is moving towards or away from an observer, there is a change in the colour of the light received from it. This shift, due to the motion of the source, is termed ' Doppler shift '.

In (*a*) we schematically depict the light wave train, and spectral line, from a stationary star. In (*b*) the star is moving away from us. The wavelength of the waves increases, and the colours in the spectrum get shifted towards the red (long wavelength) end. If the source is approaching us, Fig. (*c*), the wavelength is decreased, and the light is shifted towards the violet end of the spectrum.

The amount of shift is directly proportional to the speed of the star, and can thus be used to measure this speed

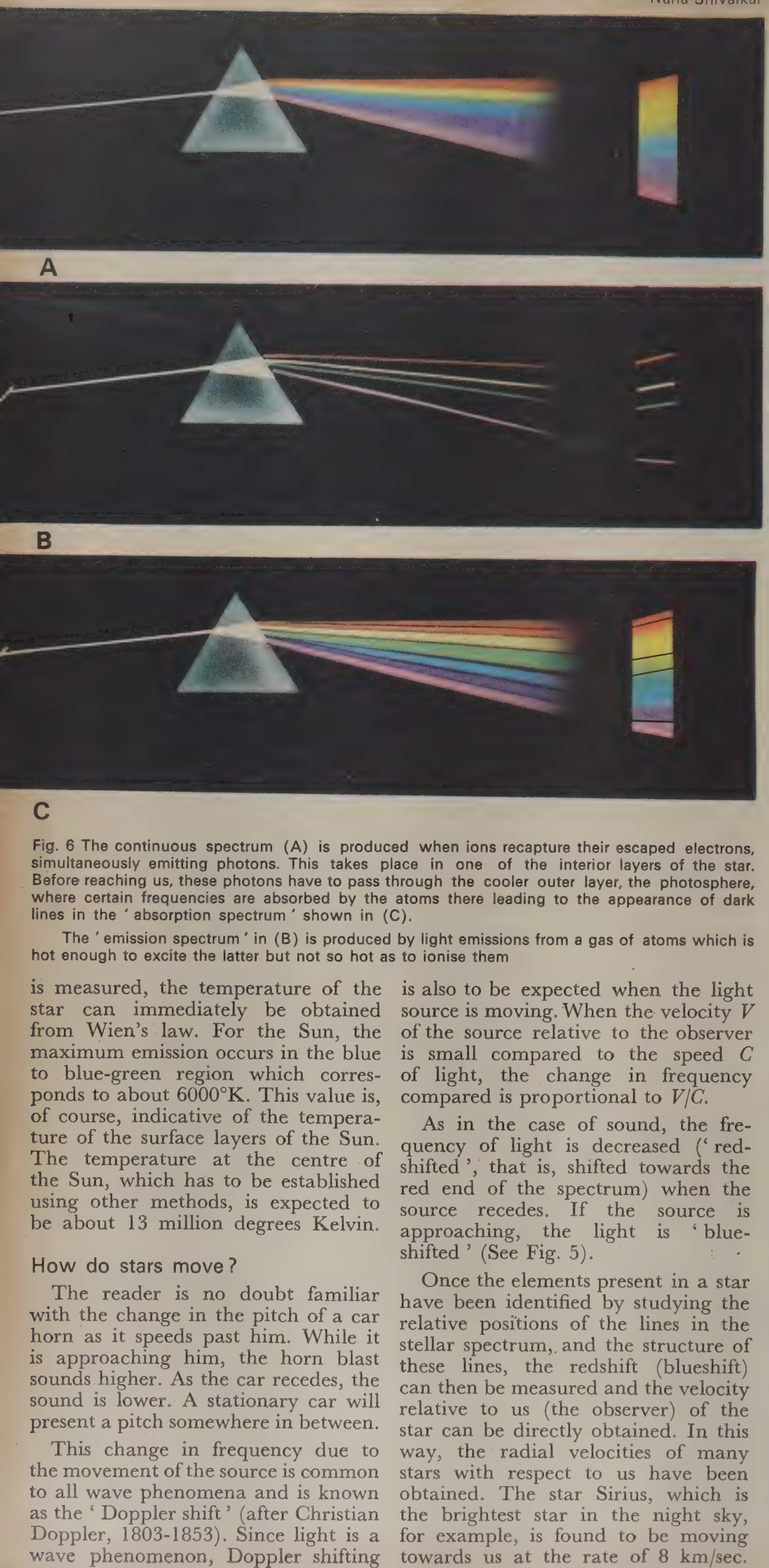


Fig. 6 The continuous spectrum (A) is produced when ions recapture their escaped electrons, simultaneously emitting photons. This takes place in one of the interior layers of the star. Before reaching us, these photons have to pass through the cooler outer layer, the photosphere, where certain frequencies are absorbed by the atoms there leading to the appearance of dark lines in the ' absorption spectrum ' shown in (C).

The ' emission spectrum ' in (B) is produced by light emissions from a gas of atoms which is hot enough to excite the latter but not so hot as to ionise them

is measured, the temperature of the star can immediately be obtained from Wien's law. For the Sun, the maximum emission occurs in the blue to blue-green region which corresponds to about 6000°K. This value is, of course, indicative of the temperature of the surface layers of the Sun. The temperature at the centre of the Sun, which has to be established using other methods, is expected to be about 13 million degrees Kelvin.

How do stars move?

The reader is no doubt familiar with the change in the pitch of a car horn as it speeds past him. While it is approaching him, the horn blast sounds higher. As the car recedes, the sound is lower. A stationary car will present a pitch somewhere in between.

This change in frequency due to the movement of the source is common to all wave phenomena and is known as the ' Doppler shift ' (after Christian Doppler, 1803-1853). Since light is a wave phenomenon, Doppler shifting is also to be expected when the light source is moving. When the velocity V of the source relative to the observer is small compared to the speed C of light, the change in frequency compared is proportional to V/C.

As in the case of sound, the frequency of light is decreased (' redshifted ', that is, shifted towards the red end of the spectrum) when the source recedes. If the source is approaching, the light is ' blueshifted ' (See Fig. 5).

Once the elements present in a star have been identified by studying the relative positions of the lines in the stellar spectrum, and the structure of these lines, the redshift (blueshift) can then be measured and the velocity relative to us (the observer) of the star can be directly obtained. In this way, the radial velocities of many stars with respect to us have been obtained. The star Sirius, which is the brightest star in the night sky, for example, is found to be moving towards us at the rate of 8 km/sec.

The transverse motion of a star, is, its motion perpendicular to the of sight, cannot be obtained the Doppler effect. A so-called " t verse Doppler effect " does exist it is small unless V is an appreci fraction of C. For stars, this is not case.

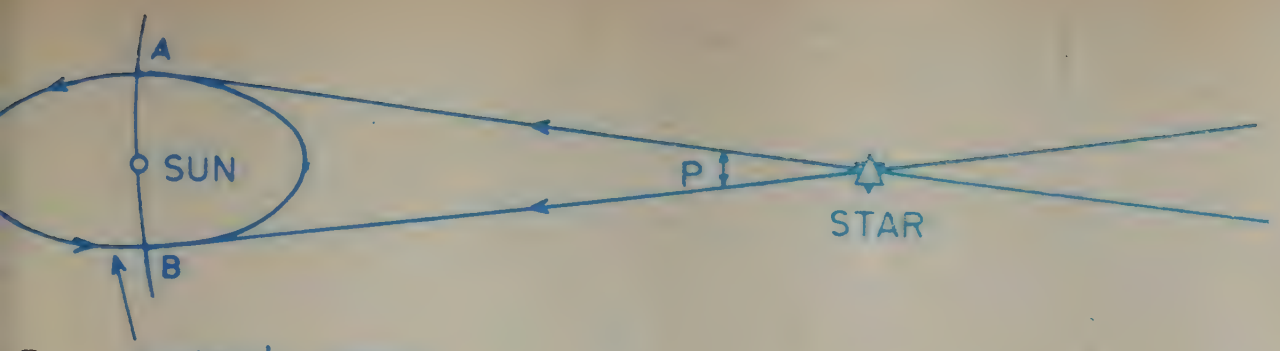
Do stars rotate?

It was discovered by Galileo, observing the apparent motion sun-spots, that the Sun rotates o axis from west to east. The Sun round once every 24 days and hours at its equator. It is not poss to determine the rate of rotation distant stars by observing some fidu marks on them because they pre point images even in the big telescopes. It is once again neces to invoke the Doppler effect in o to detect any rotation. If a sta rotating, and the axis of rotatio not directed exactly towards us, part of its surface will be moving a from us and the diametrically oppo part will be moving towards Because of the Doppler effect, light coming from the former will redshifted and that coming from latter will be blueshifted. In a po like image, it is not possible to tinguish between light coming f different portions of the stellar surfa but the effect of rotation is to broa every spectral line. The amount line broadening can be measured the rate of rotation of the star can estimated.

How far to a star?

Much information about the p perties of a star can be had by meas ing the amount of light received fr it on the Earth, and studying variation with time. The appar brightness of a star cannot, of cour tell us anything directly. A star c appear relatively bright in spite being a medium- or small-sized st simply because it is relatively close us. In order to get an idea of h bright a star really is, it is necessa to know how far it is from us. Distanc to a few nearby stars can be measur directly using trignometric metho This data can then be matched wi inferences from the variation of lig from stars to measure distances stars even in other galaxies.

The distances to the nearest sta can be measured directly using t " method of parallax ". As the Ear moves round its orbit, the place fro which we view a star is continuous changing. Because of this, t positions of the comparatively near stars (projected against the mo remote ones) are also continuous changing. A nearby star will be see



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shift back and forth against the ore distant stars as it is viewed from fferent points along the Earth's bit (see Fig. 7). If p is the angle btended from opposite ends of a ameter of the Earth's orbit (p is own as the stellar parallax), it can deduced using elementary geo- etry that the distance r is given by

$$r = \frac{360^\circ}{2\pi} \frac{AB}{p^\circ}$$

ee SCIENCE TODAY, August 1976, 61). The angle p is too small to be curately measured except for the earest stars. The star nearest to the un, Proxima Centauri, which is at a stance of 4·2 light years, has a rallax of only two-ten thousandths a degree. Distances of the order of a ndred light years can be measured ing the method of stellar parallax. bout 700 stars are close enough for is method to be applicable.

Statistical analysis of the motion stars which move in clusters can ad to distances up to several hundred ght years. These methods are less ccurate than the method of parallax, ut they form an indispensable rung the cosmic distance ladder.

There are about n thousand catalogued stars whose pparent brightness is observed to ary more or less regularly with time. uch stars are known as pulsating ariables. We shall consider here only ne type of pulsating stars, the *cepheid ariables*. The cepheid variables are ellow supergiant stars, named after ne prototype and first known star of ne class, Delta Cephei. The magnitude f Delta Cephei varies between 4·1 nd 5·2 in a period of 5·2 days. This orresponds to a two-fold change in brightness. Most cepheids have periods in the range of 1 to 50 days. The Pole Star is a cepheid variable that varies between magnitudes 2·5 and 2·6 in a period of just under four days.

Study of the spectra of these variable stars shows that variations in light intensity are accompanied by variation in temperature of the radiating surface. There is also a fluctuation in the size of the star, the changes in light output being associated with a periodic rise and fall of the stellar surface. In the case of Delta Cephei, it is found that the photosphere pulsates up and down over a distance of 2·5 million km, which is about 8 per cent of its radius of 40 million km.

The importance of the cepheid variables lies in the fact that a relation exists between the periods of pulsation of the stars and their absolute magnitudes. The relation was discovered in 1913 by Henrietta Leavitt of the Harvard College Observatory. If a plot is made of the absolute magnitude against the period of pulsation, Fig. 9 is obtained. Now, if the nature of the light variation of a star at an unknown distance shows that it is a cepheid variable, the period of pulsation leads to its absolute magnitude. The apparent magnitude can be measured in the laboratory, and the relation between the two magnitudes immediately leads to the distance of the star from us. The cepheids are bright enough at maximum light to be used up to distances of the order of 12 million light years. This is far enough to reach some galaxies outside our own local group of galaxies.

It is a very difficult problem observationally to obtain the calibration curve shown in Fig. 9. For this to be done, it is necessary to know the distances to some cepheid variables by some independent method. Unfortunately, no cepheid is close enough for its distance to be determined by the method of stellar parallax, and statistical methods involving the proper motion of the stars must be used. Corrections have also to be made to allow for the dimming due to the presence of interstellar gas. It was realised in the early 1950s by W. Baade that the cepheids were nearly four times brighter than they were believed to be earlier. Since the distances to the other galaxies are primarily based on the apparent brightness of cepheid variables in the nearest of them, Baade's correction meant that all extragalactic distances were suddenly doubled!

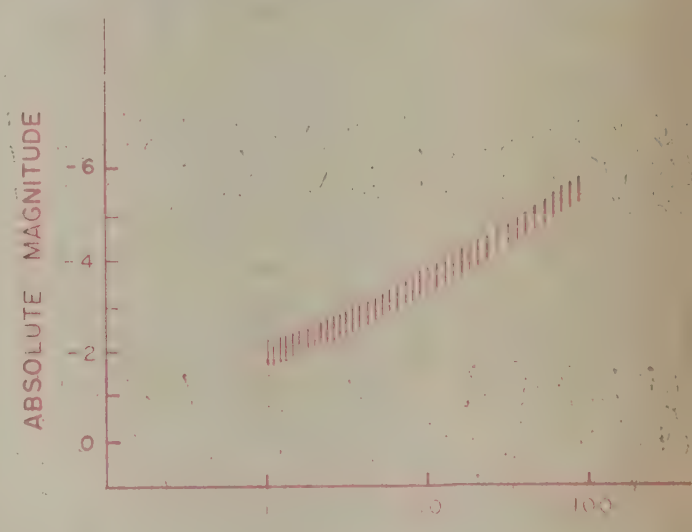


Fig. 9

How massive is a star?

The mass of a star has to be inferred from its gravitational interaction with other bodies. The mass of the Sun can be determined in this way by studying the orbits of the planets around it. Other stars, however, are too far for us to study the planets around them (if at all present), and we have to depend upon gravitationally interacting systems of two or more stars.

In the stellar neighbourhood of the Sun, somewhere between one-half and two-thirds of all stars are members of binary or multiple star systems. A binary star is a pair of stars in orbit around their common centre of mass. Some stars are visual binaries, that is,

ig. 8 Spectrum of Sirius showing the dark lines whose positions identify the star's spectral type

Nana Shivalkar

they can be optically identified as two separate stars. The binary nature of other stars, however, has to be inferred indirectly. If the orbit of the binary system is turned nearly edge on to us, the stars eclipse each other during their motion. The light received from the system when one star is in the shadow of another is less than when light is being received from both stars. There is therefore a periodic fluctuation in the amount of light received from the system, and even though the components cannot be separately observed, it can be suspected that eclipsing stars are present. It is, of course, necessary to study the nature of the spectrum to ensure that what is being observed is not an intrinsically variable star.

The two stars of a binary revolve round their common centre of mass, which in turn moves in a straight line among the neighbouring stars. It is convenient for astronomers to observe the motion of one star about the other, and to determine its apparent orbit, from which the true orbit can be derived. Kinematic analysis of the true orbit leads to the sum of the masses $m_1 + m_2$ of the two components of the binary. Investigation of the individual motion of the stars about the centre of mass then reveals what share of the total mass belongs to each star. The periods of mutual revolution of binaries range from a few years to a few thousand years. A lengthy series of observations covering a number of decades is thus necessary to obtain useful data about binaries with long periods.

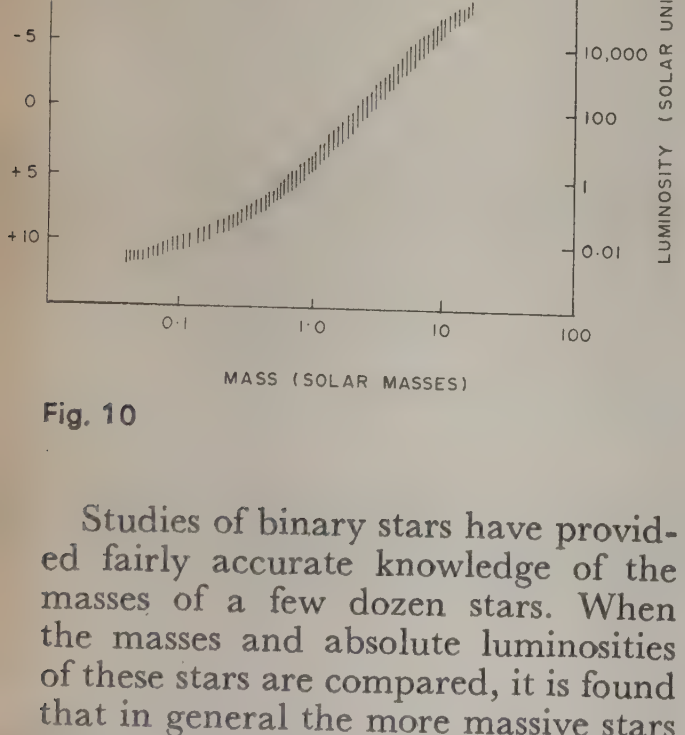


Fig. 10

Studies of binary stars have provided fairly accurate knowledge of the masses of a few dozen stars. When the masses and absolute luminosities of these stars are compared, it is found that in general the more massive stars are also the more luminous. This relation, known as the mass-luminosity relation, is shown as a plot in Fig. 10. It is estimated that 90 per cent of all stars obey the mass-luminosity relation. It does not apply to stars which are being formed or to those which are at a very late stage of their evolution. Sir Arthur Eddington first obtained an explanation of the mass-luminosity relation in 1926. The relation is a reflection of the principle that the structure of a star is completely determined by its total mass and by the distribution of chemical elements throughout its interior. The mass-luminosity relationship provides a useful method of estimating the masses of stars of known luminosity that do not happen to be members of binary systems.

Deeper inside a star

We have been seeing how astronomers combine the principles of physics with observations of the light from the stars to gain knowledge about their characteristics. These observations tell us only about the conditions prevailing in the outer layers of the star. It is the aim of the astrophysicist to combine this surface data with general physical principles like hydrostatic and thermal equilibrium, equations of state, the modes of energy transport, the opacity of gases and the rate of energy generation due to nuclear reactions, to determine the internal structure of the stars. The physical ideas are formulated into a set of differential equations which are solved to determine the march of thermodynamic variables like temperature, pressure and density throughout the stellar interior. The set of solutions obtained, based on a specific set of assumptions, is called a stellar model. The complete model ought to explain how a star is born, how it functions in its prime, and its final state after the nuclear fuel in it is exhausted. Progress is being made in this direction as greater insight is being obtained about the physical processes taking place in stars. The development of high-speed computers is invaluable in this study as much of the work involved in solving the mathematical equations is numerical in nature.

Ajit Kembhavi (27) is with the Theoretical Astrophysics Group at the Tata Institute of Fundamental Research, Bombay. His primary research interests are in gravitation theory and cosmology.

Recommends reading: **1.** Abell, G. 1964. *Exploration of the Universe.* Holt, Reinhart and Winston. **2.** Novotny, Eva. 1973. *Introduction to Stellar Atmospheres and Interiors.* Oxford University Press. **3.** Hoyle, Fred. 1975. *Astronomy and Cosmology: A Modern Course.* Freeman & Co.

IN LIGHTER MOMENTS

MOSELEY, who worked with R Rutherford, and who developed concept of atomic number as well as X-ray technique to locate all the "hol represented by still undiscovered eleme in the Periodic Table, had cordial relati with everybody. Notwithstanding his h ing hand, he sometimes felt annoyed v others for borrowing his matches regula Finally, he came up with a solution. purchased a gross of match-boxes cos 1 sh 6 d, and put them in an open pack case at the corner of his table. On the c he hung a card-board label which re "Please take one of these boxes and le my matches alone."

* * *

WHENEVER anybody — more partic larly a research worker under him referred to some aspect of his work, P Philipp Eduard Anton Lenard (1862-191 head of the physics department at t University of Heidelberg, interrupted hi "And who did that first?"

"Herr Geheimrat, you did that first," w the speaker's pet reply. And in approvi rejoinder came the Chair's remark, "Y I did that first."

Lenard had shown that the electri effects produced by light falling up certain metals were the result of t emission by those metals of electro While speaking about this, a scholar, usual, said, "Herr Geheimrat, you did th first." Poor Lenard had to tell him, "N J. J. Thomson did that first. He really d that first."

* * *

IT was only a few days after he had di covered the basic principles of th electrical transformer and the dynam that Michael Faraday was explaining the to a group of very distinguished person which included the British Prime Ministe Gladstone. Before he could finish, Glad stone interrupted to say, "But, after a what use is it?" The great experimentali scratched his head and simply sai "Why, sir, there is every probability tha you will soon be able to tax it."

* * *

ROBERT Brown (1773-1858), a Londo doctor and botanist, who was the first t observe in 1831 that the nucleus was regular feature of plant cells, had ofte been visited by Charles Darwin before th latter's *Beagle* voyage. Darwin has recalle him thus: "He was rather given to sneerin at anyone who wrote about what he di not fully understand. I remember praisin Whewell's *History of the Inductive Science* to him, and he answered, 'Yes, I suppos that he has read the prefaces of very man books.'"

S. N. MUNSH

LET'S
GET TO
KNOW
OUR
TREES !

BAMBOO:
THE TREE GRASS!

M. VAID

R. Vaid

Fig. 1 Impenetrable clump of ' giant bamboo '

ASIA, particularly the South-East Asia, may be called the ' continent of bamboo groves ' ere vast tracts are covered over by mps of the tall, graceful plants t grow amidst the trees but are not es and one can find millions living houses made entirely of bamboo terial. This is one material that is fficiently cheap and plentiful to et their vast needs — from the ild's cradle to the dead man's bier. e straight, smooth stems are light d strong, and can be easily split th ordinary hand-tools. In the mid tropics, whole houses are built tirely of bamboo without using single iron nail. In fact, there is limit to the variety of articles that n be made out of this material. lison had used the carbonised fila-ent of bamboo for his early electric lamps and the razor-sharp peel has been, at times, used in place of a surgical knife. Among the more sophisticated uses of bamboo are the manufacture of a large variety of writing paper, charcoal for electric batteries and the white powder produced on the outer surface of young stems for the isolation of a crystalline compound similar in nature to the female sex hormone. *Tabasheer*, the fine siliceous matter deposited in the hollow stems of some species, has excellent properties as a catalyst for certain chemical reactions, though in India it is prized as a restorative tonic and an aphrodisiac. In recent times, even diesel fuel has been prepared from bamboo culms by distillation.

In the plant kingdom, bamboos have a close affinity with the grasses, and in broader terms they may be rightly called " giant grasses ". However, in a stricter sense, they may be separated from grasses by certain *bambusoid* characters which may well be considered as ' primitive '. The prominent rhizome, woodiness of the stem and petiolate leaf blades are some of the easily distinguishable characters, though some other floral characters may also be listed out as features of difference. In size, they may vary from the small fishing tackle to towering poles as high as 35 metres or so, jointed and more frequently hollow and cylindrical from within.

Nearly all bamboos are green when fresh but some species have a beautiful golden colour with green stripes (Fig. 5). An occasional species has a near-black colour.

There are about 550 species (belonging to the tribe Bambuseae) unevenly distributed in various parts of the world. They are found in greatest abundance from India eastwards to Burma, China, Japan up to Korea. They are the dominant feature of the vegetation in areas where the precipitation is normally high and the temperature more on the mild side. Asia alone accounts for nearly 320 species of which 136 species occur in India, and 39 in Burma. South America accounts for 179 species and a few occur in South Africa, Madagascar and Australia.

The bamboo can grow almost anywhere — from the sea level to the

Fig. 2 Growing shoot of ' giant bamboo '. (Left) First week. (Centre) Second week. (Right) Third week.

R. Va

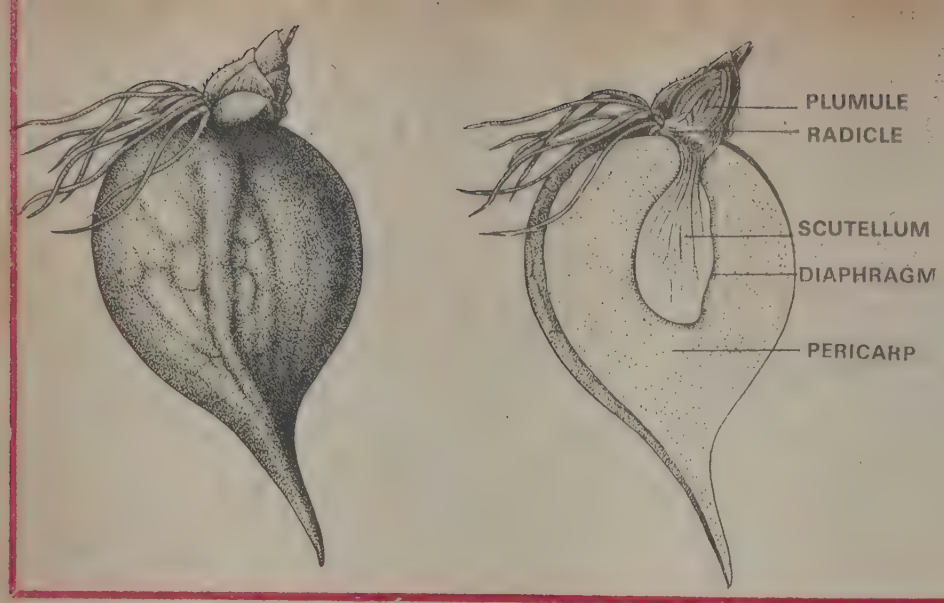


Fig. 3 *Melocanna baccifera*. Diagram shows two halves of a germinating fruit. The thick pericarp is all starchy food material

snowline. The plant attains maximum growth in the monsoon forests where pure stands cover vast stretches of land. In the temperate regions and at high altitudes, they dwindle to the size of small shrubs. In India, West Bengal, Assam, north-eastern Himalayas, the Western Ghats and the Andamans are particularly rich in bamboo.

Bambuseae can be divided into four sub-tribes: Arundinarieae, Dendrocalameae, Eubambuseae and Melocanneae, embracing about 30 genera in all. Out of these, the genera *Arundinaria*, *Bambusa*, *Cephalostachyum*, *Dendrocalamus*, *Gigantochloa*, *Melocanna* and *Ochlandra* are by far the most important from the commercial point of view and a majority of these are indigenous to India, Burma, China and Malaysia. The distribution of bamboos, however, has been greatly altered by human intervention and natural stands have been more or less cleared off (for shifting cultivation), particularly in the north-eastern hill tracts of India. The other intervention comes from the paper industry which clears and plants bamboos according to its needs.

Fig. 4 Flowering clump of bamboo (*Dendrocalamus strictus*). Close-up shows the flowers. Profuse flowering precedes death of the clump

The structural foundation of the bamboo plant is the underground, segmented and highly condensed rhizome which goes on propagating vegetatively. (Rhizomes of some species have been passed off as rhino horns! And some bamboo roots are used for making polo balls.) The aerial part generally collected as bamboo is called the culm and several culms arising out of the ramifications of the rhizome are collectively called the clump. When they occur in dense impenetrable thickets, they are c the ' congested clumps ', which i general feature of most bam The seeds produced by these are small and grain-like. How there are a few other bamboos have laterally spreading rhizo In this case, the culms arise sing intervals and are called ' clumps '. This is particularly characteristic of the tribe Melo neae and the seeds of this type large and fleshy.

Culms arise from the rhizomes depending on the species, they ma mere shrubs as most *Arundinaria* or they may become giants reac a height of about 35 metres as in case of *Dendrocalamus giganteus*. M bamboos grow erect, but a few, s as the *Teinostachyum helferi*, are st glers. There are still other forms the *Melocalamus compactiflorus* wh are slender climbers stretching the crowns of tall forest trees. believe it or not, a Chinese variet actually square in shape.

The growth of the bamboo plant is indeed remarkable. During the monsoons new shoots emerge from the ground in the form of buds. These are wrapped over by strong, sharp-pointed sheaths covered with minute irritant hair. The tender shoot inside is very delicate and luscious, but at the same time is very poisonous (containing hydrocyanic acid). Perhaps, this is how nature protects them from the ravages of grazing cattle or other wild animals. These shoots are a great delicacy and serve as supplementary food. The poisonous effect is destroyed after boiling. It is then cooked, or made into pickles. The popular belief is that new shoots sprout only when there are thunder and lightning. Besides the fact that, during the monsoon showers, lightnings are a rather common phenomenon, there could be a scientific basis, too! The mass of shallow bamboo roots makes a compact mat and exhausts the soil of its nutrition all around the clump. The physiological effect of lightning is that (*i*) it converts the atmospheric nitrogen into nitrates which are washed down into the soil with the rainwater, thus replenishing the impoverished soil and providing much needed nutrition to the sprouting buds, and (*ii*) strong intermittent flashes break the dormancy of the buds.

R. Vaid

Fig. 5 Golden bamboo. Note the young shoot covered with sharp-pointed culm sheaths

Curiously, flowering has not been observed in the golden bamboo in the past 150 years or so

Elongation of shoots takes place gradually in the initial stage and then they become so active as to grow in leaps. In some of the tall species like *D. giganteus* and others, they may grow two to three feet (0·6 to 1·0 metre) in one day. If one has patience to sit for hours by the side of the growing culms, one can even see the actual process of lengthening. Once a forest officer had left his hat on a growing bamboo shoot and when he returned to retrieve it the next day, he could not reach it even with his outstretched hands. The three photographs (in Fig. 2, p. 31) illustrate this point graphically. The characteristic of fast growth of the bamboo was at one time employed by the Chinese kings as a method of forcing criminals into confession. A hardcore criminal would be tied on a seatless chair and placed over the growing shoot. Within a short time the bayonet-sharp tip would begin to pierce the body of the criminal; and the confessions would come soon enough.

R. Vaid

Fig. 6 Culm sheaths dropping off after one year

The bamboo shoot grows to its full length in about two months' time and by then the rains also come to a stop. The sheaths remain attached to the nodes for a whole year till the culm become hard. A white powdery bloom also covers the tender skin of the culm which disappears as the culm matures.

The culm sheaths fall off after the bamboo matures. Actually, the sheaths' shape and size differ from species to species and this character has been fairly effectively employed as an aid in the identification of bamboo species (because their flowers are seldom available). Bamboo clumps go on adding shoots and become

Fig. 7 Cluster of *muli* fruits growing at the nodes. Since such fruits are not easily dropped by the wind, they may become viviparous

Fig. 8 *Melocanna baccifera* fruits germinating on the forest floor. Some fruits can be seen still hanging from the lowest nodes

R. Vaid

R. Vaid

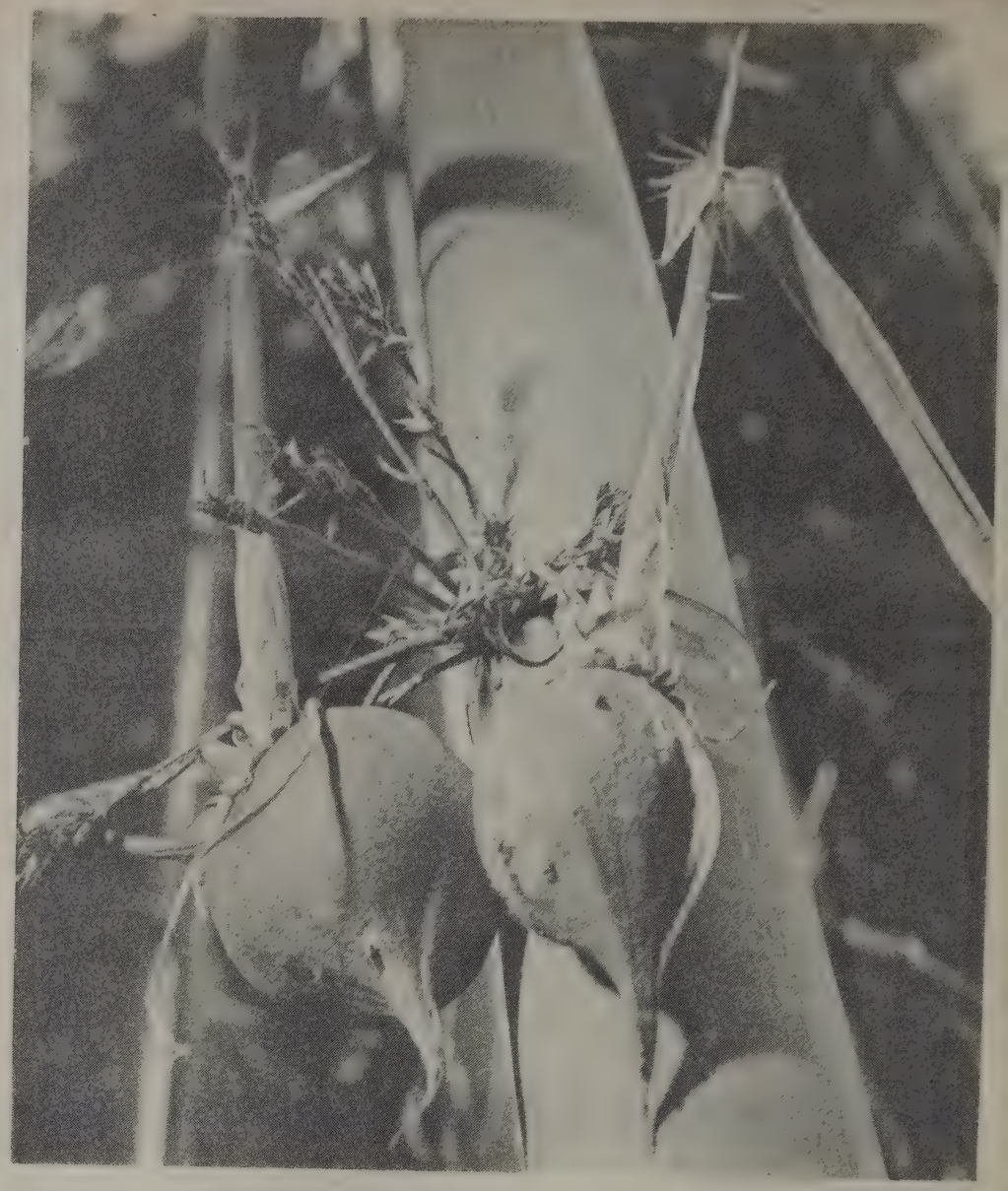


Fig. 9 Viviparous fruit of *Melocanna baccifera* (muli bamboo). Root and shoot are well-formed before the fruit drops

impenetrable thickets. Within three to five years, on the average, the culm matures and turns brownish. And here's another very distinctive characteristic of the bamboo: irrespective of whether the mature culms are cut or not, the bamboo flowers only at fixed periods, and *not just every year*. The flowering interval also varies with species and in most cases, the interval may range from 25–50 years. In some species, the interval may be shorter, three years or so; a few may flower even annually.

When general flowering takes place, the spectacle can be breathtaking; it is all the more exciting when we consider that this flowering takes place only once in the lifetime of a species. No matter where the species grows or whatever be the age of the clump, it happens all so spontaneously. The exact cause leading to the general flowering is still a mystery, but it is believed that a short rainy season followed by a long spell of hot weather promotes flowering. Perhaps, this may explain the popular superstitious belief that bamboo flowering is an indication of an approaching large-scale drought, famine or epidemic. Congenial flowering conditions are indicated by the cessation of all vegetative activity; *no fresh leaves or culms are produced for a year prior to flowering.* They lose their foliage, and when finally stripped of leaves, the culms burst forth in flowers. (Bamboos which flower once in their lifetime are termed ' monocarpic '.)

The flowering and seeding activity of bamboo continues for a long period, sometimes as long as two years. Such enormous quantities of grain-like seeds are produced that the entire forest floor gets covered with grain. Where famine conditions prevail in the countryside, people from the neighbouring villages collect in large numbers and gather the seeds. As has been pointed out earlier, the tribe Melocanneae, particularly *Melocanna baccifera* (Roxb.) Kurz, the *muli* bamboo of Assam, bears large fleshy fruits the size of guavas. These, too, are produced in large quantities and are all starch. People collect them for food and eat them raw or cooked. And wild animals relish them ravenously. Whatever is left on the ground or remains untouched between the spaced culms begins to germinate from the broader end and soon sends forth a growing shoot above and a few roots downwards. The sharp, pointed end helps the fruit to get embedded in the soft, wet soil as it falls from a height of six to nine metres.

Some of these large fruits growing close to the node or even at the ground level do not get dislodged easily from the parent plant. Such fruits begin

germinate while still on the tree nd carry a well-formed shoot about 0 cm long by the time they are ropped to the ground (Fig. 9). Such condition is called ' vivipary ' and is n extremely rare phenomenon.

It has been estimated that 30 to 35 ears is the usual flowering cycle in ne case of the *muli* bamboo although rratic flowering at intervals of 12 nd 45 years has been observed in ome localities. *Melocanna baccifera* syn. *M. bambusoides*) flowered over undreds of square kilometres in its atural habitats in Meghalaya, Assam, Arunachal Pradesh, Mizoram and orth Bengal from 1958 to 1960. And, handful of these bamboos planted n Dehra Dun (more than 2,000 km way) began to flower *simultaneously*. t has also been observed that flower-ng occurs in waves, starting from one nd of the forest and ending at the ther in about two years' time; this is articularly true of the localities where pure forest of a single species is rown over extensive areas.

Fig. 11 An industrial plantation of bamboo. Extraction becomes easier because of even spacing between clumps

R. Vaid

Myths surround the amboo, many of them born in com-nunities used to living with calamities. We have already mentioned how the rodigal flowering of bamboo is taken o be of great significance because t portends famines and epidemics. n such difficult times, the rare occur-ence of general seeding of bamboo is godsend, for it provides supple-mentary food. One of the popular beliefs is that the rat population increases when the bamboo has flowered and the seed lies on the ground. Perhaps a rational explanation would be that, where there is a bountiful supply of seed available in a particular spot, there is also the possibility of a large influx of rodents from the neighbouring areas where severe drought conditions have led to a failure of crops. Sexual reproduction in rats is rapid and over a period of about two years even the well-fed offsprings will give birth to millions of young ones. The result is that the rodent population reaches an astronomical figure in a small area. The people attribute the increase to the general flowering-fruiting of bamboo. Thus are many of the myths born.

The popular association of bamboo flowering with floods, too, may have some basis. Rats store quantities of food grains in long tunnels that they burrow into the mudbanks along the rivers. Millions of such holes drilled in the embankments of the Brahmaputra were a leading cause of the dykes being weakened, resulting in inundation of the land around.

There is also the eventuality of forest fires. It so happens that the culms which are dry and congested often rub against one another when there is wind. The friction creates enough heat to cause fire, and it does not take much time for a whole forest to be set ablaze.

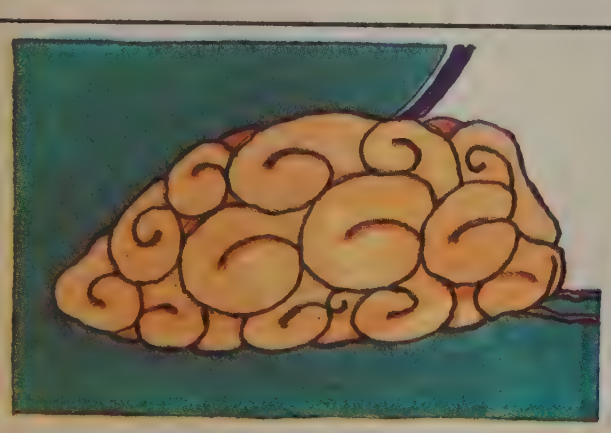
The bamboo dies after its periodic flowering. All the species do not flower at the same time, but it is certain that all plants of a species will flower simultaneously, no matter where they are. It is as if the germ plasm of every seed is provided with an alarm clock set to go off at a certain time. The seeds germinate readily and in a short time a fresh crop springs up. For the first few years the seed-grown plants look like grass. Quite a lot of them are destroyed by animals but sufficient numbers survive to replenish the forest stock. Interestingly, since the flowering of different species takes place at different intervals, there is practically no chance of producing hybrids in nature.

ig. 10 *Dendrocalamus giganteus* or giant amboo, 25 to 30 cm in diameter. The hollow nternode can hold 10 to 15 litres of fluid. hey are quite handy for para-dropping of upplies and for making rafts for rescue perations in flood-affected areas. Tribal people arry water in them and forest labour prepare ea, etc, in green bamboo tubes placed directly ver the fire

R. Vaid

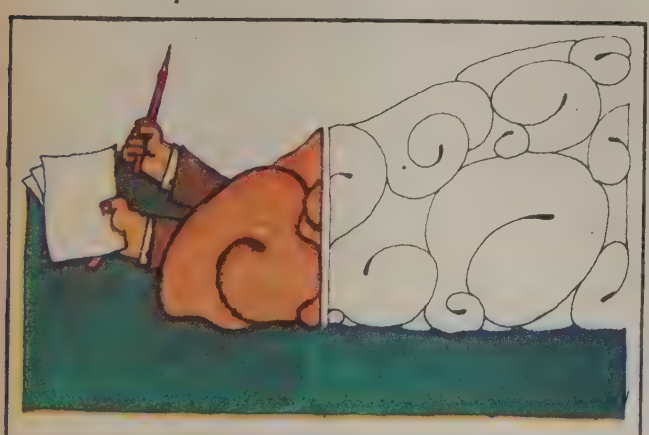
K. M. Vaid (54) is Senior Research Officer in the Botany Branch of the Forest Research Institute, Dehra Dun, where he has been working since 1948. His special areas of interest are taxonomy, flora of the northwestern Himalayas, and identification of tree-themes in Indian archaeology. His research article on the "Wishing Tree" will appear in SCIENCE TODAY next month. Mr. Vaid is also a well-known photographer of Indian flora; besides several of his photographs published in the *Wealth of India* series, three of his colour transparencies have been used for the recently released four stamps of Indian flowers.

What it's all about . . .



Five rupees! That's all you are worth, chemically speaking — cartilage, muscle and bone. But the brain. . . .

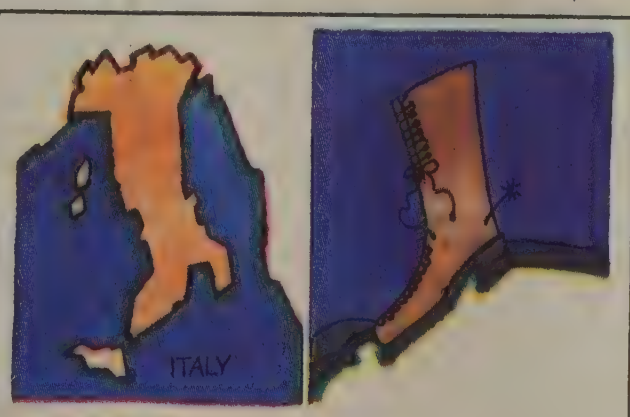
The brain's a different thing. It generates power. It's worth millions.



Perhaps the greatest blunder one can commit is to underestimate one's powers to develop and accomplish. This is true of most of the brain's faculties, including memory.

Remember the many, many occasions when you had to recall lists of all sorts — shopping, sales, study points — and how you struggled to recall even parts of the list?

Perhaps you've accepted that your memory is shockingly bad. It isn't true.



Through association you connect thoughts in your mind and, as a result, each thought will bring to mind other thoughts that are linked with it.

That's why, you'll remember the shape of Italy better if you picture it in your mind's eye as a boot.

You'll remember more easily that the port light of a ship is red if you remind yourself that port wine is red.

The telephone number 365521 can be associated with 365 days which equal 52 weeks which again equal one year.

The 'by-heart' memory or rote memory is a pitiable thing. Rote memory makes you tired and bored. Only parts of your mind are working. In some ways, it's like loading a gun for just one blast — say, at the examination.

Actually, the difference between a good memory and a bad memory is only a matter of training.

Memory is something like a muscle. Exercise it and it will perform almost any feat. Neglect it and it will become flabby and atrophied.

What you need is a trained memory. How do you go about it?

Here are 10 easy steps of training yourself to remember what you wish to remember.

Let's start with STEP ONE. . . .

STEP ONE

Let's test your memory. Here you hav a list of 20 words.

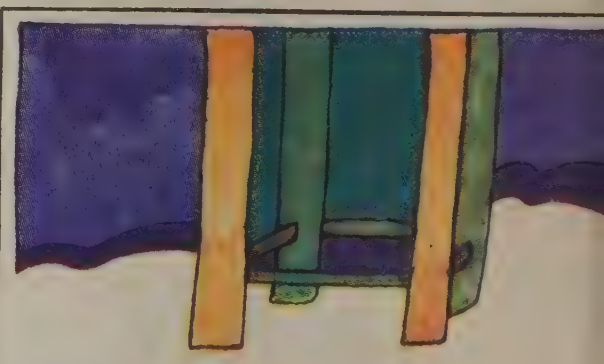
BOTTLE TABLE LEGS PANTS MONE
APPLE KNIFE FISHERMAN GOL
HOTEL KING HORSE DOCTO
NEWSPAPER PIPE TELEPHON
WINDOW BIRD GUN COWBO

How long would you take t remember these words? Five minutes And in order? Seven to 10 minutes Close this magazine and repeat o write them down. Well?

How long would you be able t retain them? Three months? Si months? Not so sure, are you? Well I am not surprised. Ask any graduate i he or she remembers the specific lessons taught in school. The answer will be, no This is because the student wasn' taught a proper system of retention.

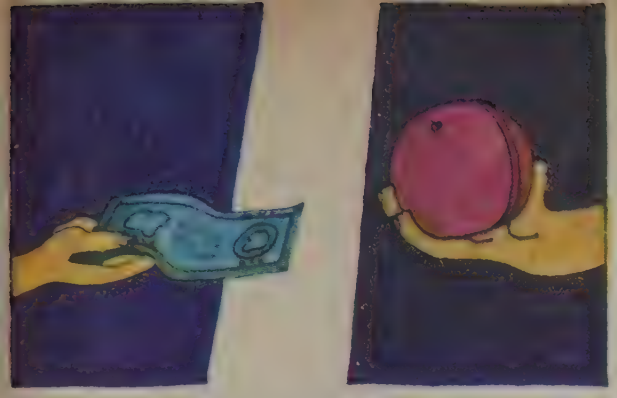
Let's try out a method of memorising the list of 20 words in order, in just a minute. All you have to do is this. Imagine . . . . .

1. A bottle on a table.

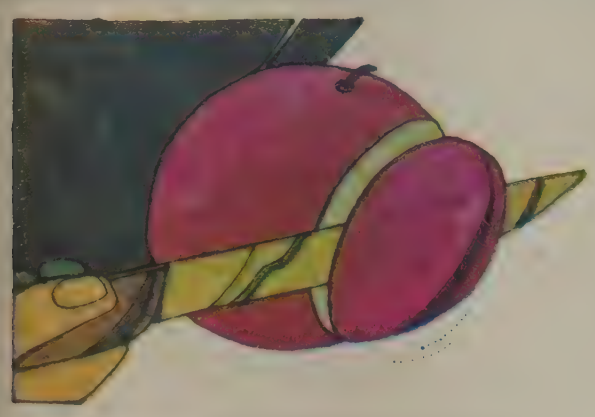


2. The table has legs.

3. The legs are covered with pants.



5. With the money you buy an apple.



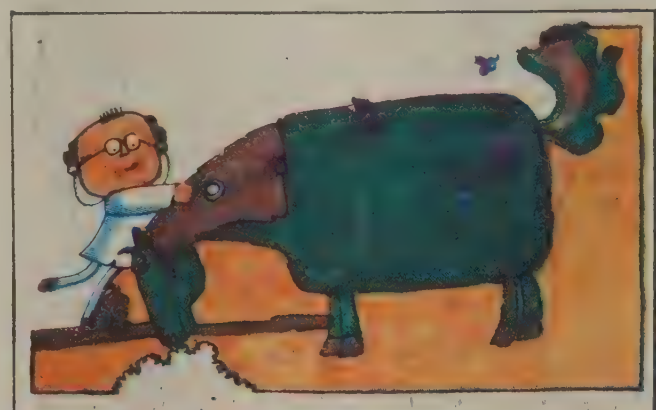
6. The apple is cut with a knife.

7. The knife is held by a fisherman.

8. The fisherman is smuggling some gold.

9. With the gold he stays in a posh hotel.

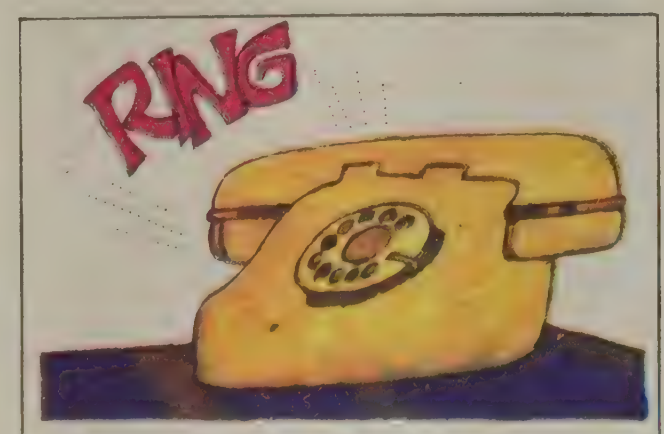
11. The king is on a horse.



12. The horse is sick and needs a doctor.

13. The doctor is reading a newspaper.

14. . . . and smoking a pipe.



15. The telephone bell rings.

16. He runs to answer the telephone

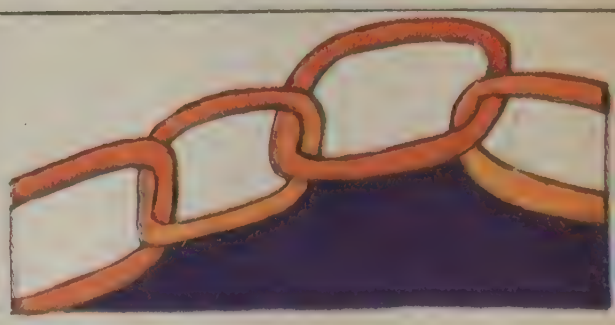
17. At the window, he sees a bird in the sky.

18. The bird is shot down with a gun.

19. The gun is in a cowboy's hand.

It took us exactly 45 seconds. If you can remember this list, you can remember any other list, too.

Now, let's see if you know what we did. We associated the 20 words — the first with the second, the second with the third, and so on. And while we were associating each with the other, we imagined moving pictures in our mind, in the form of a story. These pictures will remain firm in the mind because we deliberately made them unusual or ridiculous and, therefore, vivid.



This is called the CHAIN SYSTEM.

The words are linked to one another to form a chain.

The chain system helps you to remember any amount of ideas, or

(Contd. overleaf)

Next month:

STEP TWO:

THE 'PEG' SYSTEM

clues in a sequence. This is usually helpful in remembering a list of jobs, discussion points, facts, places, study points, reports, etc.

In a nutshell . . . memory training is training the mind to understand, grasp, learn, assimilate and retain the maximum information in a short time with the least effort by using the most effective method, ready for future recall.

The secret of good memory is the secret of forming diverse and multiple associations with every fact one cares to retain. Remembering has three steps — learning, retaining, and recall or recognition. Like all exercises, memory training must be applied faithfully through determined practice and sincere effort.

EXERCISE :

Here are two sets of 15 words for you to memorise :

NEWSPAPER OVEN UMBRELLA CAT FISH JAR BUSH CUCKOO GUITAR TOMATO BUTTER SPOON BUCKET HONEY JENNY.

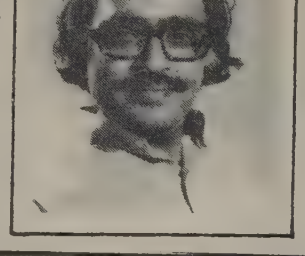
TOOTHBRUSH TOWEL BANK TEA COAT CUB GIRL POLICEMAN CAP ROSE BIRD HELICOPTER MINISTER JAIL BANGALORE.

Give yourself 3 minutes to study the two groups of words using the " chain system ". Associate two words at a time — the first with the second and so on, making a firm link of the chain pattern, seeing the moving pictures in your mind's eye, no matter how unusual, ridiculous or frightful they may be, as long as they are striking. The more the association is developed, the more systematic and orderly your thinking becomes. Form strong and interesting associations. You will notice that your association is different from others, and yours is the best which will come up to your mind easily and quickly.

K. S. VAZ

Kevin S. Vaz is a management consultant and heads a memory training academy in Bombay. He has written several books on memory training and was awarded the " Ten Outstanding Young Persons " 1977-78 National Award for his pioneering work in the field of memory education in Asia.

S. A. Sabir, the illustrator of the series, is a well-known graphic designer and decorative illustrator from Bombay.



About this series :

Advertisements keep appearing abo memory improvement courses that t reader could avail of via mail ord Also, journals and newspapers th carry such advertisements keep receivi letters from readers about how th have failed to derive their money worth. So, why should SCIENC TODAY begin a series on memo improvement techniques ?

In November 1977, SCIENCE TODA had published a group of articles experts which discussed the vario probable mechanisms of memor The articles revealed unequivocally th we know very little about the mecha nisms of memory. What about th mnemonic aids then — the techniqu known to the Greek and Indian schola for over a millenium ? After all, these c seem to work in remembering name dates, items in lists, etc. Well, suc techniques work because they tra us to attach significance to insignifica items.

This series attempts to show how is done. Remember, mnemonic system are known as ' artificial memory because they teach you to place item to be remembered in a predetermine schema. And, therefore, despite th title, the ' improvement ' must neces sarily be limited.

But, then, let's get on with it, because as we have found out, it's a lot of fun

—ED

Three-speed bicycle hub

THOUGH the bicycle has been with us for decades, not much thought seems to have been given to improving its performance, either by reducing the effort required in cycling or by increasing the speed in relation to effort. Since about 30 million people in the country move about on bicycles, they would welcome any improvement in the bicycle.

A system of gears is useful for riding fast (in the top gear) and to climb slopes without getting off the bicycle (in low gear). Both can be achieved with the same effort.

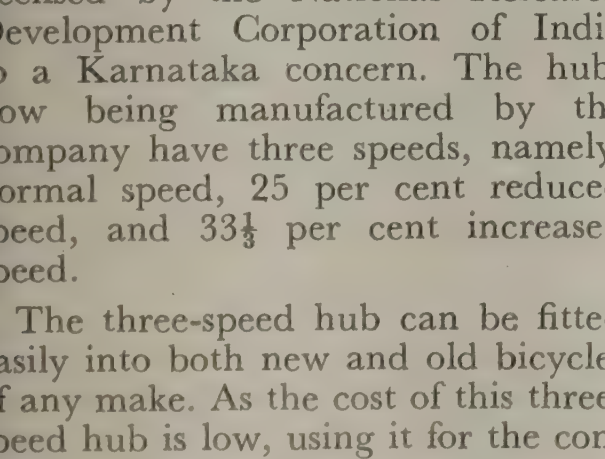
The Regional Research Laboratory (RRL) at Jorhat (Assam), has developed designs for multi-speed hubs (three speeds and five speeds). There are said to be only about four manufacturers in the whole world who produce this type of multi-speed hubs, but these are fitted to cycles for joy rides rather than for regular use. The design of the three-speed hub developed by the RRL, Jorhat, was licensed by the National Research Development Corporation of India to a Karnataka concern. The hubs now being manufactured by the company have three speeds, namely, normal speed, 25 per cent reduced speed, and $33\frac{1}{3}$ per cent increased speed.

The three-speed hub can be fitted easily into both new and old bicycles of any make. As the cost of this three-speed hub is low, using it for the conventional hub of the bicycle gives a sizeable advantage at a nominal extra cost. The shifting of the clutch is accomplished by a simple and reliable trigger control device attached to the handle box. The approximate weight of the multi-speed hub is 1·3 kg.

The basic principle of the five-speed hub is similar to that of the three-speed hub. In the five-speed hub there are two gear trains instead of one. Here we get five different gear ratios, i e, 0·67, 0·77, 1, 1·3 and 1·48. The cost of production of the five-speed hub will be higher by about 25 per cent than that of the three-speed hub.

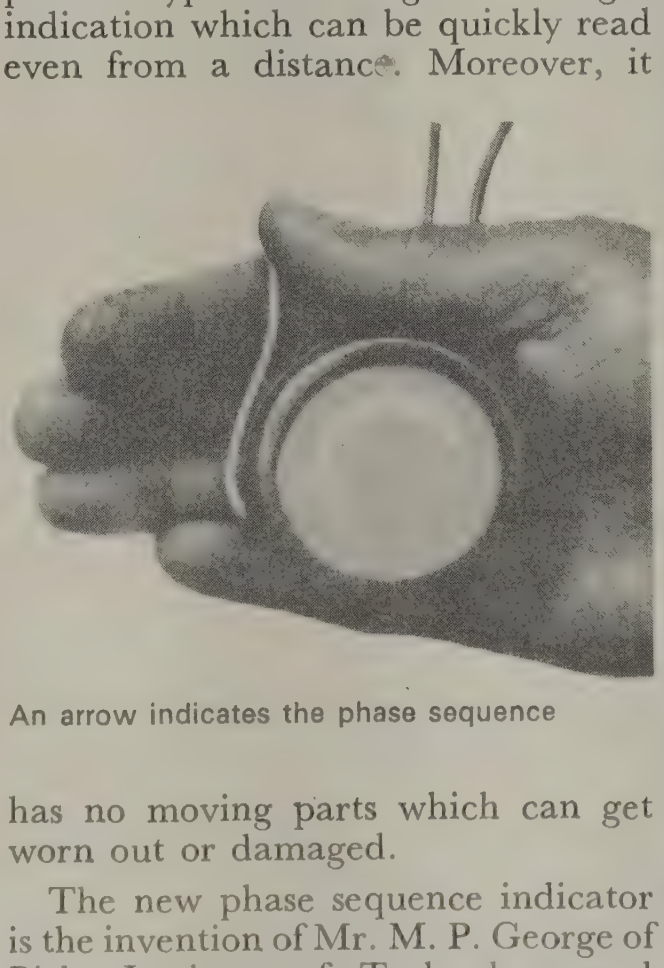
P.K.

The three-speed hub can be fitted into bicycles of any make



Phase sequence indicator

A NEW phase sequence indicator (Indian Patent 137560) has some important advantages over the currently used rotating disc type and pointer type phase sequence indicators. For example, it can be produced for less than Rs 10 a piece, as compared to Rs 100 to Rs 200 a piece for the rotating disc type and Rs 150 to Rs 250 a piece for the pointer type. And it gives a larger indication which can be quickly read even from a distance. Moreover, it has no moving parts which can get worn out or damaged.



An arrow indicates the phase sequence

The new phase sequence indicator is the invention of Mr. M. P. George of Birla Institute of Technology and Science, Pilani, Rajasthan. It uses an arrow system to indicate the phase sequence of a three-phase supply. It can also give indication of excessive voltage.

The three-phase AC supply is the most economic mode of generating, transmitting and utilising electric power on a large scale. Its two most important attributes are: (*i*) the three wires carrying the three-phase supply normally have the same AC voltage; and (*ii*) the AC voltage variations in the three wires are not synchronous but 'phased' with respect to time. The peak of the AC voltage in each of the three phases occurs at equal intervals, usually 1/50 second — which means that the voltage peaks in the three wires (say, A, B and C) are 'phased' in a regular 'sequence'. Since there are only three elemen involved, there could be only two suc sequences, i e, A-B-C-A-B-C an C-B-A-C-B-A. Mr. George's inver tion offers a very simple, direct readin system that tells whether the sequenc is A-B-C or C-B-A.

The working principle of the ne device is based on the fact that th currents in two resistance branche connected in star configuration with condenser across a three-phase suppl are not equal. The resistances in th device are replaced by neon lamp which, when lit, cast the illuminate shadow of an arrow on a screen.

A circular model of the devic shown in the photo has a front scree of a translucent material and ther are three different coloured leads a the periphery. When the device connected to a three-phase system, a illuminated arrow appears on th front screen. In the photo, the direc tion of the phase sequence indicate by the arrow is anti-clockwise; the direction of phase sequence i opposite, a reverse arrow woul appear on the screen.

Mr. George's phase sequence in dicator can be produced in any desire shape and size and it would weig less than 100 gm. It is so designed tha it suffers no damage even if it remain connected for years in a three-phas circuit. Its power consumption i negligible in comparison with th conventional types.

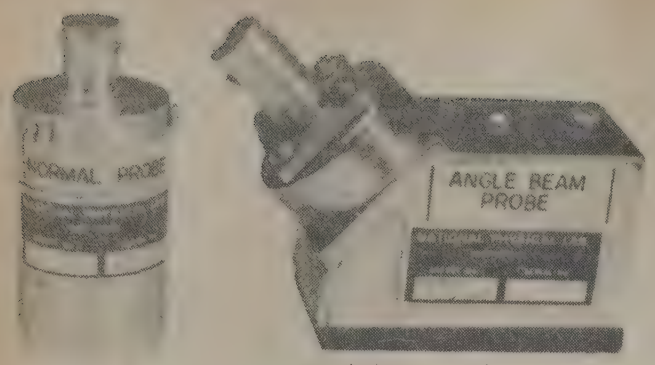
BADIUDDIN KHAN

Probe heads for ultrasonic non-destructive testing applications

ULTRASONIC non-destruc tive testing techniques ar being used for detection, loca tion and sizing of flaws, cavities shrink holes in engineering materials Ultrasonic methods of testing ar fast, reliable and relatively inexpen sive. Also, only one surface of th material to be tested need be accessible

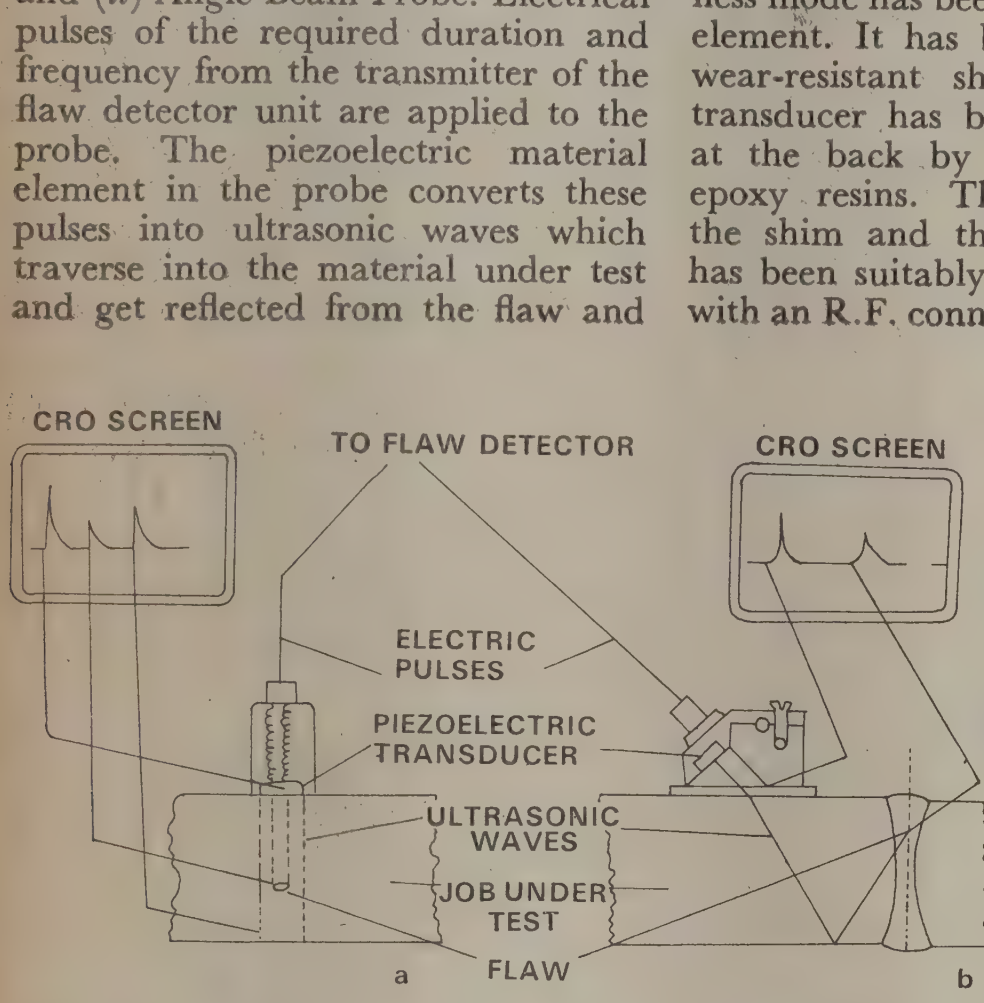
A large number of probe head are in use for ultrasonic non-destruc tive testing (NDT) work and they are the most important part of the test equipment. In fact, the probe head is the heart of the ultrasonic flaw detector and usually gets damag ed or worn out in use.

The ultrasonic probe is used to transmit and receive ultrasonic waves



Normal beam probe Angle beam probe

in the material under test. The figure below shows the working principle of the ultrasonic flaw detector unit in conjunction with (*i*) Normal Beam Probe and (*ii*) Angle Beam Probe. Electrical pulses of the required duration and frequency from the transmitter of the flaw detector unit are applied to the probe. The piezoelectric material element in the probe converts these pulses into ultrasonic waves which traverse into the material under test and get reflected from the flaw and



Schematic diagram of ultrasonic detector with (*a*) normal beam probe and (*b*) angle beam probe

from the other side of the job under test. After the transducer has transmitted ultrasonic waves (for a short period), it stops vibrating for a period long enough to receive the reflected echo. A part of the reflected waves is picked up by the piezoelectric transducer and is converted into electrical pulses which are amplified by the amplifier of the flaw detector unit, processed by the time base unit and displayed on the cathode ray tube screen. The interval between the initial pulse and the arrival of the reflected pulse is a measure of the distance at which the flaw is situated.

Even though a few firms are manufacturing the ultrasonic flaw detectors in the country, they have been importing these probes in large quantities from foreign countries for their equipment. A survey also indicated that there was a large number of imported flaw detectors lying idle or under-used with various industrial and government establishments, due to non-availability of these probes. The technology for the manufacture of these probe heads is a well-guarded secret of a few foreign firms.

The development of such probes at National Physical Laboratory, New Delhi, was taken up by a team of scientists consisting of the authors and Mr G. K. Kohli with a view to set up the indigenous production. No worthwhile help was available in the shape of published work. The following three probes were developed: (*i*) Normal Beam Probe, (*ii*) Angle Beam Probe and (*iii*) Surface Wave Probe.

Normal Beam Probes: In the developed probe, an electroded piezoelectric ceramic transducer vibrating in thickness mode has been used as the sensing element. It has been mounted on a wear-resistant shim. The vibrating transducer has been suitably loaded at the back by metal impregnated epoxy resins. The transducer with the shim and the backing material has been suitably housed in a casing with an R.F. connector through which electrical signals from the flaw detector unit are applied to the transducer.

These probes transmit ultrasonic energy into the job under test at right angles to the surface and are used for detecting blow holes in castings, cracks caused by metal fatigue, flaws in metallic and non-metallic materials and for assessing the physical and metallurgical characteristics of the material by measurement of velocity and attenuation properties of the material.

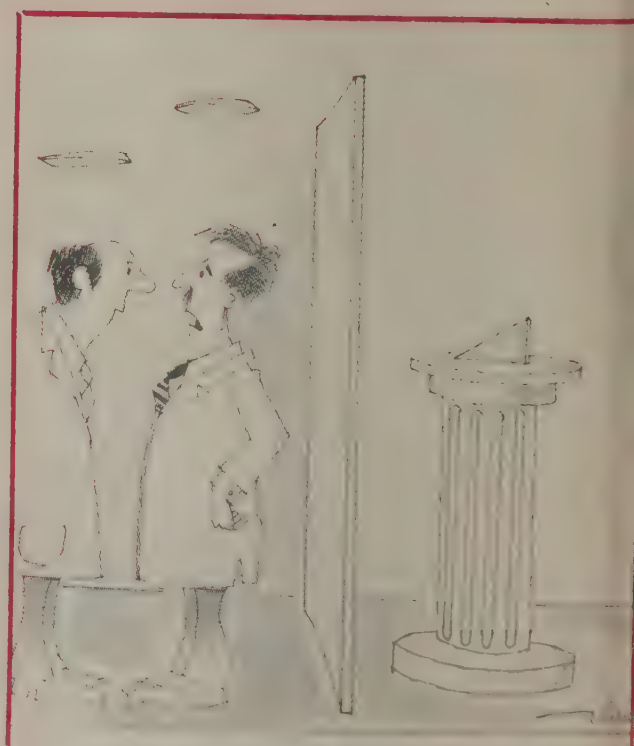
Angle Beam Probes: In these probes also, a piezoelectric ceramic transducer vibrating in thickness mode has been used. This transducer has been fixed on a mode changer wedge having suitable dimensions which converts the longitudinal waves generated by the transducer into transverse waves when the probe is placed on the job under test. Suitable backing material and trapping blocks have been employed to enhance the quality of the wave transmitted. An electrical matching network has been employed for optimising the power transfer from the flaw detector unit to the transducer and vice-versa. The vibr ing transducer along with mo changer, backing block, trappi block, matching network, etc, h been housed in a suitable casi having an R.F. connector. A repla able plastic shoe has been provid to enhance the life of the pro head. These probes transmit ultr sonic energy (transverse waves) at certain desired angle into the j under test and can thus scan the pa of the specimen which cannot scanned normally owing to the sha and other physical limitations of t specimen. These are used for detecti the flaws and cracks in pipes a plates, for testing welded joints, f testing of axles or railway locomotive rails and a wide variety of oth applications.

Surface Wave Probes: These prob are a special type of angle bea probe and are similar in constructio to those described above. They ha been designed in such a way th they send ultrasonic waves at grazing angle along the surface of th job under test; they are recommende for testing flaws which occur just nea the surface, eg, fatigue cracks i turbine blades, etc.

The commercial know-how for th manufacture of these probes is no available from the National Researc Development Corporation of India New Delhi. A few firms have alread gone into production on NP know-how. These probes are no commercially available in the countr and are being used by various in dustrial and government establish ments.

V. N. BINDAL
VINOD GOGIA

[Dr. Bindal and Mr. Gogia are with th National Physical Laboratory, New Delhi]



'Are you serious about entering your 'clock that works on solar energy' for the National Awards?"

Science and Security

The quest for national security, in the shape of evermore destructive weapons of offence and defence, has in fact come to mean more insecurity for everybody. There are now enough nuclear weapons in the arsenals of the superpowers to kill everybody on earth several times over. However, there are subtler killers than bombs and bullets. What more effective method of eliminating the enemy than by preventing him from growing his food or by sapping his will to fight — by means of chemical agents? Or by stealing vital information from him? In this series, Dr. N. Seshagiri, a free-lance defence analyst, points out the technological threats to the security of nations posed by such developments as the cruise missile, chemical weapons and tiny nukes. No less important are the threats to individual security, and the first article deals with a common one — the violation of the privacy of wire communications by tapping and bugging.

SNOOPING BY TELEPHONE

N. SESHAGIRI

A TELEPHONE is a means of communication and often a status symbol. Since a pair of telephone wires enters the house of anybody of importance; it is also the simplest and most direct means by which law enforcement agencies, or even private detectives, can gain access to the citizen's innermost thoughts by the simple expedient of tapping or bugging his telephone. But few telephone owners know how their phones may be tapped or bugged; hence they may suffer grievous loss through leakage of information to their business rivals or political opponents. An attempt is made here to describe in simple terms the various methods of telephone tapping and bugging and also the counter-measures that one can take to protect one's privacy.

The most common example of the principle behind a tap is the extension telephone. However, an extension draws additional power and, therefore, causes the electrical characteristics of the line to change perceptibly. If a tap were to be designed entirely analogous to the extension telephone, it could be easily detected by using appropriate equipment. Those who are keen to tap a telephone without being detected would go in for devices which affect the electrical characteristics of the line as little as is technically feasible.

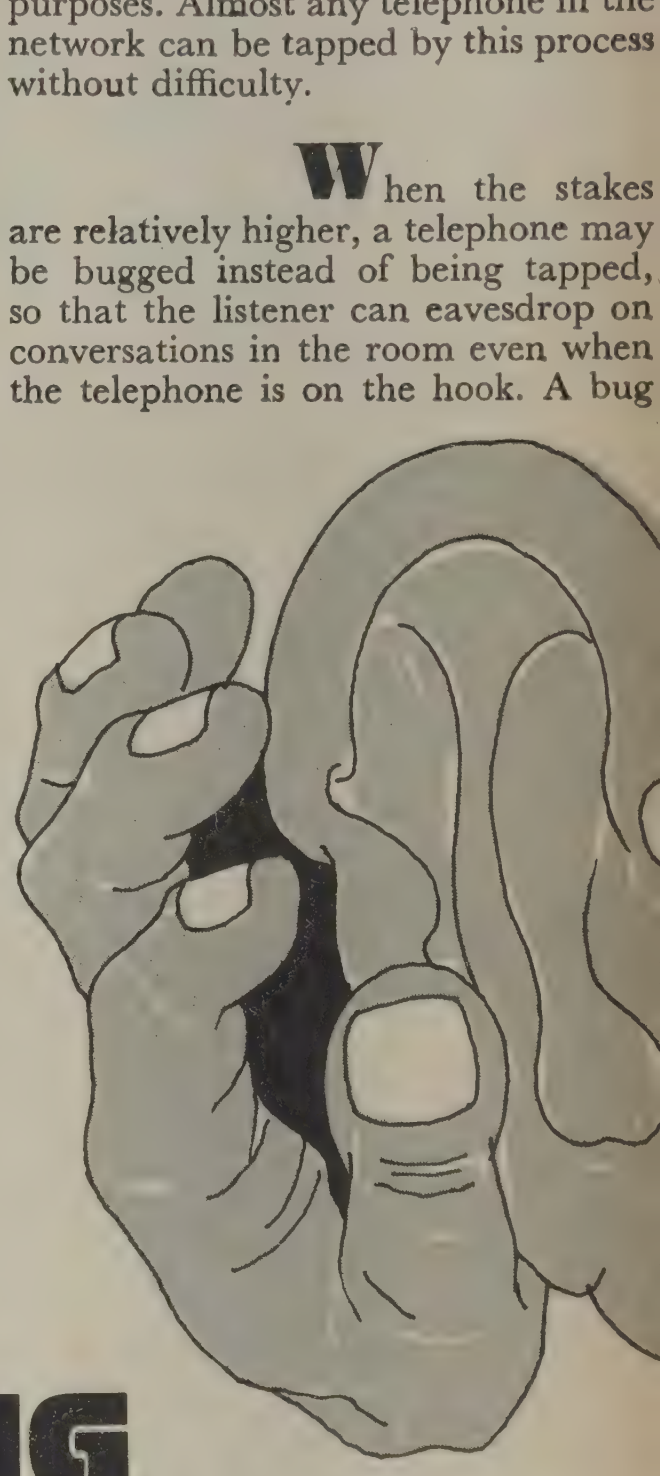
It is common knowledge that if a very high impedance is connected in series with the load, the latter would draw very little power from the line. It is this principle which a detection-proof tap exploits. Even though the signal embodying a conversation over the telephone is very small, there are numerous types of electronic circuits available for amplifying the signal, using a separate power supply.

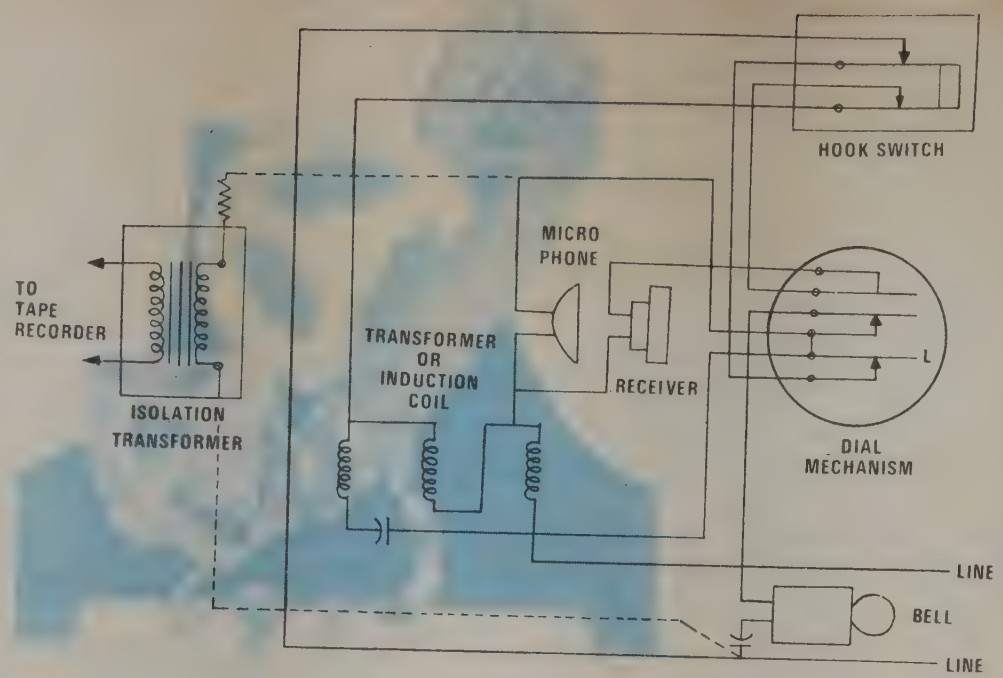
As continuous surveillance by human operators is cumbersome, the tap invariably is connected to a concealed tape recorder. This can be connected in parallel with the telephone outside the exchange and may be operated with batteries of its own. Sometimes, instead of a tape recorder, special miniaturised concealed radio transmitters are also deployed.

The simple, low-cost taps are deployed against subjects who are unsuspecting or unaware of the technicalities of tapping. The common version uses an induction coil located in the field created by the fluctuations of currents in the telephone wire, actuated by a conversation over the phone. The coil can be either near the telephone wire or in the telephone instrument itself. In monopolistically owned telephone networks, it may be possible to plant the coil within the telephone instrument itself during repair or servicing. The coil, however, is required to be connected to a concealed miniaturised radio transmitter.

Many busy executives in India might have experienced intervention by exchange operators announcing the coming through of a long-distance call when a local telephone conversation is going on. The call, however, may not materialise and the operator, who is in fact tapping the line, merely makes the announcement to cover up. In a monopolistically owned telephone network, under certain political exigencies, such facilities may be used by governments as a means for eavesdropping on the telephones of political opponents from the telephone exchange itself. Certain unscrupulous operators may also use such facilities on behalf of clandestine employers for commercial or industrial espionage purposes. Almost any telephone in the network can be tapped by this process without difficulty.

When the stakes are relatively higher, a telephone may be bugged instead of being tapped, so that the listener can eavesdrop on conversations in the room even when the telephone is on the hook. A bug is a clandestine electronic device for eavesdropping. It so happens that for obvious functional reasons, a telephone is always situated at the most effective place in a room, that is, near the subject; this makes it the most effective place for planting a bug. In addition, existing wiring and existing microphones in the telephone can be utilised, rather than separate ones. Normally, the bug is placed somewhere between the subject line and the central exchange. As the wire box is already a maze of wires, addition of a few more may go undetected for a long time and the tamperer can keep a colour tag for his wires. The





This circuit diagram shows the basic connection of a telephone tap. The external connection is shown by dotted lines. The basic circuit of the telephone instrument is given in solid lines

link can be a direct wire or a radio-transmitter kept concealed away from the room being bugged.

Another common bug is a miniature microphone planted in the telephone in parallel with the ringer and the hand-set, in addition to the existing one. All the components needed for a microphone are already there in the ringer. Designs based on direct connections do not interfere with the telephone conversation, but can be detected simply by listening on the line when the receiver is on the hook.

Among the professional bugs, the " hook-switch bypass device " is commonly used. A simple capacitor can bypass the switch blocking the D.C. voltage from the exchange, but allowing the audio A.C. Here, a dynamic earphone functions as a microphone. A 10-kilo-ohm resistor can send enough current through the carbon microphone in the hand-set to activate it without activating the exchange. For guarding against interference with normal telephone calls as well as to get a good signal, a resistor and a capacitor are put in parallel. As there exists the possibility of detection of the bug by listening on the line, four such hook-switch bypass devices are used in such a manner as to be turned on by a signal from the listening post. Certain electronic components like reverse-biassed diodes, Zener diodes and even neon lamps can be used as automatic switches for cutting off the bypass if there is an incoming call, or if the hand-set is lifted for putting through a call. The most effective component, however, is the Triac which requires a micro-second high-voltage pulse turn on but keeps dormant if the f of current is at a low level.

Infinity transmitter

In this age of sa lite communication, telephone tapp has reached the international sc of operation. A device, significan named " infinity transmitter", u a special switch activated by characteristic tone. The mo operandi is very simple. The eav dropper rings the subject, keeps m (or says it's a wrong number) wh the called party answers and th keeps the line open by not hanging even after the subject does. He th puts through a characteristic to from a tone generator and activa the bypass switch in the telepho instrument of the subject. The te phone at the other end will then as if it went off the hook again. It claimed that this method is bei employed in listening in to the co versations of important personalit and political subjects from lo distances. It is said to be the m effective bug in the world and probably being used by various int ligence agencies.

How effective this approach necessarily depends upon the type telephone network installed in t country. When the infinity transmitt is on, the line is blocked for the i coming calls. For the system prevaili in the United States, for exampl

Pen registers

The size of a small suitcase, the device is a composite of a reel of magnetic tape, several dials and switches and a digital display screen. Connected to a telephone line, " the device will record automatically on tape and show on the display screen all the numbers called from the phone, what time the calls were made, how long they lasted, and when incoming calls were received ", says a recent issue of *Science* (17 February 1978). This is the old " pen register ", now being advertised as " telephone decoder ". Further, if the device also has an internal relay for switching on an external recorder, a snooper could plug on a tape recorder to the pen register and actually listen to the conversations, too.

Pen registers were developed originally for use by the phone companies to check how well their call-metering devices were working. They were also used to detect " fraud calls ", made by people who avoid paying for the calls by using " blue boxes " that transmit the calls but bypass the billing mechanism. Another use was to investigate harassing or obscene " callers ", after their identity had been suspected.

In recent months, pen registers have been used by both private business houses (to check if employees ' misuse ' phones for long-distance personal calls) and intelligence agencies. And this has evoked vigorous protest from the American Civil Liberties Union. The issue is now being taken up by the US Senate and House sub-committees for investigation. The American Privacy Foundation believes, pen registers actually pose two problems. One, extended pen register surveillance of a person's ' phone activity ' — who he or she calls, when and for how long — can help construct a " behavioural profile " of an individual in complete violation of his or her privacy. Second, once a pen register is installed, it can tempt the operator to eavesdrop on the actual conversation also.

The problem is compounded by the fact that, unlike in wire-tapping, pen registers are often installed legitimately by the telephone company itself or law enforcement agencies on the strength of a court order. However, the telephone company does not ask questions as to how the installation is actually being used. The fear of the civil libertans is based on the 1975 exposure of the CIA's ' mail cover ' operations. Under the US law, law enforcement officials may ask the Postal Service to show them all the incoming and outgoing mail from a given place. In 1975, it was disclosed that, besides recording the addresses on the mail, the CIA had also been *reading* the mail — for 20 years or so. The pen registers could be misused in a similar manner.

The debate on a citizen's right to privacy has taken a serious turn — at least in the USA — because the American Telephone and Telegraph (AT&T) company and its subsidiaries are beginning to incorporate the pen register technology into the Electronic Switching System (ESS) which is being installed at telephone switching stations around the USA to replace the older mechanical stations. With the ESS, the telephone company can — with the flick of a switch — keep track of all the numbers called from a given phone, instead of physically attaching a pen register to the subscriber's line. And the record can be kept indefinitely.

Although the telephone company defends the ESS on the ground that it will prevent wrong billing of subscribers, others are not so sure that that's all the ESS will do!

P.P.

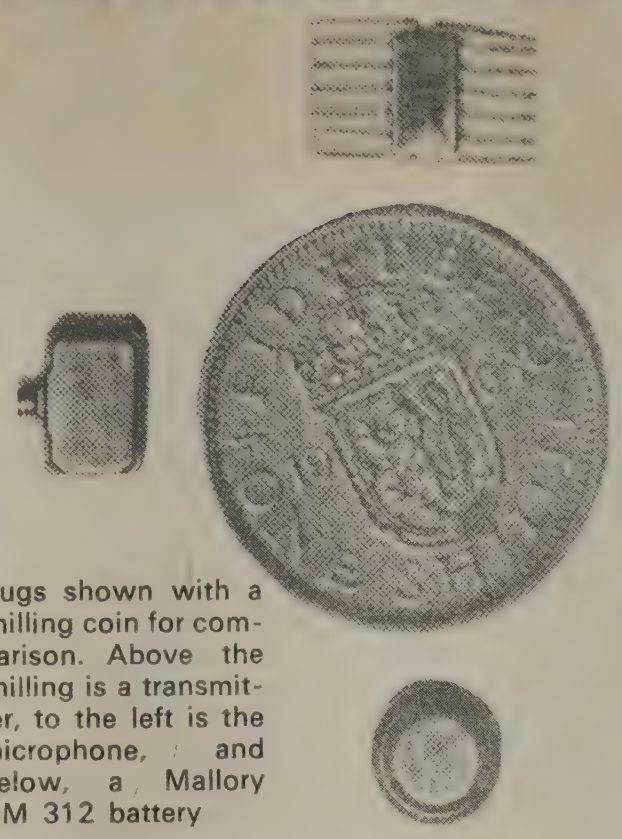
THE WALLS HAVE ELECTRONIC EARS . . .

ANYBODY who wields power needs to know what his opponents, or even underlings, are thinking. And the appetite for information is not confined to authoritarian regimes. While formerly spies and informers did the job, they are now aided by a host of ultra-tiny electronic devices whose existence is barely suspected by the man-in-the-street. The ' telescreen ' of *Nineteen eighty-four*, a sort of electronic Argus which monitors the words and actions of party members in their residences, is a rather primitive gadget compared to today's sophisticated listening and recording devices. For instance, the laser bug (said to be on the British Government's secret list) bounces a laser beam off a vibrating object like a window pane; the sound patterns that cause the vibrations are decoded from the reflected beam by the listener. (Incidentally, the use of the word ' bug ' in this sense is attributed to Thomas Alva Edison's reference to a ' bug ' in his phonograph, meaning a problem analogous to that caused by an insect getting into the phonograph.)

Most countries have by now realised that bugs, like nuclear weapons, are a double-edged weapon. Some have stringently regulated their manufacture and use. Others are either not sufficiently worked up to pass legislation or are not able to easily enforce their laws. Thus, in Canada and Japan, all bugging devices are openly offered for sale. In the UK, the use of electronic devices is prohibited unless permitted by the Home Secretary. France permits their use to protect public order or state security but requires the signature of the Prime Minister for each tap. West Germany prohibits the sale of these gadgets within the country but not their export. In the USA, law enforcement agencies must obtain a court order for their use; the greater part of illegal eavesdropping in the United States is now confined to marital cases (between husband and wife), and industrial espionage. In India, at present, wire-tapping is apparently being done only to curb anti-social activities; last December in reply to allegations that phones of MPs were being tapped, the Prime Minister said in the Lok Sabha that phone tapping was not being done in relation to political activities.

The trouble with electronic bugs, as with firearms and nuclear weapons, is that once having been developed and found useful, it is difficult to outlaw them totally. Even if only law enforcement agencies are allowed their use, they might be tempted to use them against political opponents of the administration.

Perhaps the most egregious example of electronic eavesdropping was Watergate, the Waterloo of President Nixon. In the early hours of 17 June 1972, five men broke into the Watergate (Washington) premises of the Democratic Party



Bugs shown with a shilling coin for comparison. Above the shilling is a transmitter, to the left is the microphone, and below, a Mallory RM 312 battery

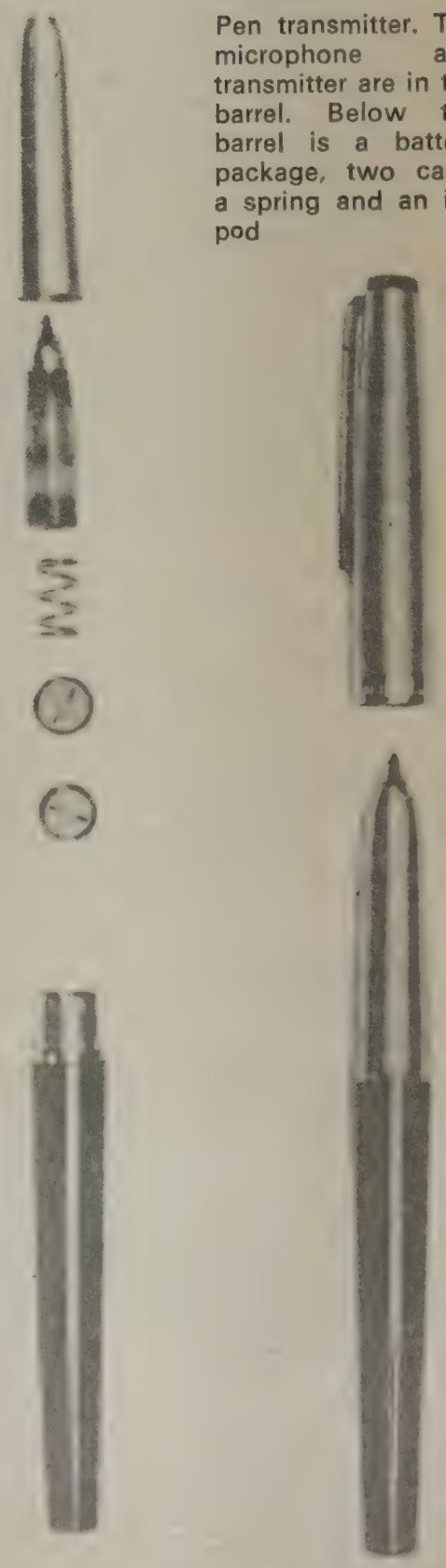
National Committee. They were arrested and later charged, *inter alia*, with tapping telephones, planting electronic surveillance devices and stealing and photographing documents. The "plumbers", as the group was known in the White House, turned out to be part of a concerted programme by the Nixon government to influence elections and to stop information leaks; this included wire tapping of political headquarters and even residences of candidates. In the words of Senator Ervine, what the Watergate intruders were seeking to steal was " not jewels or money . . . but something much more valuable — their (the people's) most precious heritage, the right to vote in a free election".

But Nixon's desire to eavesdrop on his opponents appears to have been part of his illusion that he and his utterances were part of history. Since the spring of 1971, he had every conversation of his in the White House recorded for ' historical purposes '. ' Presidential locating boxes ' were installed showing where exactly the President was at any moment. Tape-recorders would be activated automatically whenever the ' presidential location light ' showed that Mr. Nixon was present. The listening devices could pick up even a whisper. . .

One safeguard against indiscriminate use is that sophisticated bugging electronics is not cheap. A two-hour miniature tape recorder cost £350 in 1973 and a transmitting pen, £69. The big buyers are military and police intelligence; manufacturers prefer them to private detectives, who apart from jibbing at the price-tag might require six hours of instruction on their use. One UK manufacturer does not sell to private detectives in Britain but sells to foreign private detectives; one set of bugs he sold to a Lebanese came back to Britain where it was used in a divorce case and resulted in the jailing of a private detective.

P.K.

> " The tremendous scientific and technological developments that have taken place in the last century have made possible today the widespread use and abuse of electronic surveillance techniques. . . . Every spoken word relating to each man's marital, religious, political or commercial concerns can be intercepted by an unseen auditor and turned against the speaker to the auditor's advantage. "
>
> — Senate report relating to the US Code concerning the privacy of oral and wire communication.



Pen transmitter. The microphone and transmitter are in the barrel. Below the barrel is a battery package, two caps, a spring and an ink pod

the snooper can prevent the phone of the subject from ringing and make connections without his knowledge. The British system, however, is different and the tapping can be foiled simply by picking up the phone after every incoming wrong number to force the snooper to hang up.

Considerable research efforts have gone into the development of telephone tap and bug detectors. One of the sophisticated detectors available in the open world market is typically represented by the " telephone analyser ". This gadget costs Rs. 30,000 a piece, which is unfortunately far beyond the means of individuals and even organisations. This gadget measures the voltage and current of the telephone when it is on the hook and sounds an alarm if these are outside the normal range. It detects the infinity transmitter by means of a tone generator, generating tones sweeping across suspected ranges of triggers for the tapping device. By connecting the analyser to the line and listening with the phone on the hook you can find out if room noise suddenly comes through. The tone sweeps will then pass through the trigger tone far too soon to register the effect. The analyser enables one to listen for any signal being transmitted over the line before and after a tone sweep. Next, the voltage and current are measured off the hook. Subsequently, with the telephone disconnected from the exchange, the resistance and capacitance are measured. If normal voltage trigger devices show up, special types of oscilloscopes can identify the type of devices through the type of pattern obtained on the screen. Such detectors are also available at lower prices, in the lower performance ranges. Unfortunately, such devices may give too many false alarms as there are variations even in the normal electrical characteristics of the telephone system. Even from phone to phone, there is an appreciable variation of impedance, depending upon the length of the line and other characteristics.

As detection is a costly process, attempts have been made to increase the reliability of prevention. A wire tap trap can be attached to a telephone, which can prevent taps by carrying out voltage checks. This is, however, ineffective against high impedance taps or bypass switch bugs. As tapping by a tape recorder, which turns on when the telephone is actually used, is quite common, the wire tap trap simply raises the voltage so that the tape recorder does not get activated. Further, if the voltage on the wire tap trap is set at a particular level preventing the flow of current, the exchange may never know. This is similar to the Phone Phreaks' Box which permits calls to be made to a telephone without being charged.

In India, unfortunately, comprehensive legislations do not exist for preventing the unauthorised tapping of a telephone. Nor can countermeasure devices be connected to the telephone or line without the explicit approval of the P & T Department. Tapping by private individuals is covered only under the sanctions against tampering with telephone equipment belonging to the P & T Department as well as for the theft of electricity. If the telephone system is not damaged and the snooper provides his own power supply, he may be legally booked only for diversion of electricity and marginally for tampering with the telephone. With an infinity transmitter, the snooper actually pays for the call and, therefore, cannot be booked even for pilfering electricity unless it is proved that the bypass switch has diverted electricity. The snooper, if caught, may get penalised only for the diversion of electricity, which is a relatively much smaller offence attracting relatively much less punishment.

As the telephone network is the most widespread communication medium, invasion of its privacy poses one of the biggest threats to individual freedom and security. Any nation cherishing a democratic way of life must impose strict and direct legal provisions discouraging tapping and bugging of telephones.

A MANUAL ON WIRETAPPING

How do you bug a suburban residential telephone? Follow these steps: " 1. Visually trace drop wire to the distribution terminal. 2. Climb pole, open terminal enclosure and note colour code of the [wire] pair in the distribution cable to which the drop wire is attached . . . "

How do you intercept a firm's data communication to a computer service? Among the steps: " 4. Dig a trench from building to branch feeder cable and dig up cable. 5. Install gas pressurisation bypass. Drill two small holes (say 24 inches apart) in cable sheath, being careful not to damage wire pairs and clamp bypass to the two holes."

And to intercept calls from a given phone in another city? Avoid the coaxial cables on account of their high voltage hazards. Rather intercept the microwave relay. " 1. Locate microwave repeater sites for the route of interest either through physical observation or from FCC filings. 2. Acquire the use of a small firm along the route . . . " and so on.

Believe it or not, the above instructions are printed in the third and final volume of a US study of the vulnerability of the US telephone system to interception (*Selected Examples of Possible Approaches to Electronic Communication Interception Operations* by C. W. Sanders, G. F. Sandy & J. F. Sawyer. MTR-7461. The Mitre Corporation, Metrek Division, January 1977). The study was commissioned by the White House. The first two volumes are written in technical language. But the third, some thirteen pages, is written in simple colourful language.

Afraid that the more enterprising amongst the populace might be tempted to dig up its cables and drill holes in them, the AT&T pressurised the White House to stop publication of the report. The US National Security Agency added extra pressure. Both were overruled. In the US, there's something called the Freedom of Information Act, whose express purpose is to enable taxpayers to get their hands on the documents and reports that they pay for.

So, now, the US telephone services might be flooded with requests for scrambling devices.

A word about scramblers. These are devices that distort telephone or radio signals by inverting high sound frequencies to low ones, alter the normal amplitudes of speech, break up the stream of sounds into segments and transpose them, or combine several of these methods. Some advanced scramblers use pulse-code modulation which converts a voice signal to digital pulses; the pulses are then redeciphered. P.P.

NEXT MONTH: THE FOOD WEAPON

Dr. N. Seshagiri (36) is Director of the Information, Planning and Analysis Group (IPAG) of the Electronics Commission at New Delhi. He has worked on power systems planning, OR techniques, national planning methodologies and strategic systems analysis. His book *The Weather Weapon* was published in 1976.

(The article is based on the trade literature of a number of private companies abroad which manufacture and market not only the tapping and bugging devices but also the anti-tapping and anti-bugging devices.)

What Happens When You Go Without Food?

A look into the physiology of fasting . . .

KISHOR MISTRY

NO living organism can survive without food. The statement needs to be qualified by adding the word, "indefinitely". The ability to adapt to short periods of lack of food is an evolutionary heritage. Besides, in many religions, wilful abstinence from food has been accepted as a holy act. Hence, the question arises: what happens to the body during fasting?

Sticklers would, of course, insist that fasting must be understood as quite distinct from starvation where the food-deprived person's mind is literally obsessed with the thought of food. Fasting is a conscious act; however, it is not known to what extent the mental preparedness influences the body's capacity to sustain itself without food for prolonged periods.

Historically, of course, there are records of long fasts. Mahavir, the Jain saint, is believed to have taken food for only 249 days during his 12-year-long *sadhana*. Pythagoras is said to have fasted for 40 days prior to his examination at the University of Alexandria. Mahatma Gandhi undertook 21-day-long fasts on three occasions. The longest abstinence from food on record is perhaps the 249-day-long fast undertaken by a 54-year-old woman at Ruchill Hospital in Glasgow in 1966.

Perhaps, the best way to look at the effects of fasting is to begin with what happens when one feels hungry. Although hunger is a subjective feeling, there have been some explanations as to its physiological cause. A fasting stomach shows rhythmic variations in tone which increase and decrease the pressure inside it. These variations occur thrice a minute. At intervals, a series of powerful contractions, lasting about half-a-minute, occur. These contractions are the "hunger pangs". Early experimenters believed these to be the result of stimulation of local sensory nerves in the stomach. Further studies, however, have established that the control of these contractions comes more significantly via both a neural and a hormonal route. The hormone may be one secreted by the stomach itself. The neural control comes from two centres — satiation and feeding — located in the hypothalamus in the brain. Actually contractions of the stomach are not the sole factor responsible for hunger sensations, because it has been found from animal experiments that severing the vagus nerve does not inhibit the food intake. There are other factors involved, like gastrointestinal secretion, glucose level in the blood and specific dynamic action (that is, the heat evolved during digestion).

Hunger is a temporary reaction to food deprivation. As fasting is prolonged, the body makes several physiological and biochemical adjustments to meet the energy requirements — by drawing on the reserves.

This is important. To remain alive, the body must spend a minimal amount of energy — this is known as the basal metabolic rate (BMR) or the metabolic 'cost of living'. Normally, the breakdown of organic molecules in food liberates the energy locked in their intermolecular bonds and this energy is utilised by the various body cells in performing their various biological works. Part of the total energy liberated gets transformed into heat, part goes into performing 'work', and part is used by the body during periods of growth. The 'metabolic rate' thus gives the total energy expenditure per unit time. The BMR, which differs from person to person, is measured (by O_2 intake) with the individual at rest in comfortable temperature conditions and without having eaten for at least 12 hours (because the metabolic rate is 10 to 20 per cent higher after eating). The variations in BMR depend as much on body size as on age and sex.

Now, under fasting conditions, as soon as the body turns to its reserves for nourishment, it automatically begins to economise on energy expenditure, too — in other words, the BMR tends to get lowered. This is done in several ways. Physical movements are minimised. As the body wastes away, it loses weight and so less energy is needed for the bodily movements. Also, wasting away reduces the actively metabolising cell mass and the energy needed for the metabolism is, therefore, reduced. Other factors which contribute to lowering of the BMR are the relaxing of the resting tension (tonus) of the voluntary and involuntary muscles and the lowering of the body temperature.

TABLE 1 : Changes in the chemical composition in the body of a hypothetic normal 65-kg man who lost 25 per cent of his weight after partial voluntary starv tion for six months.

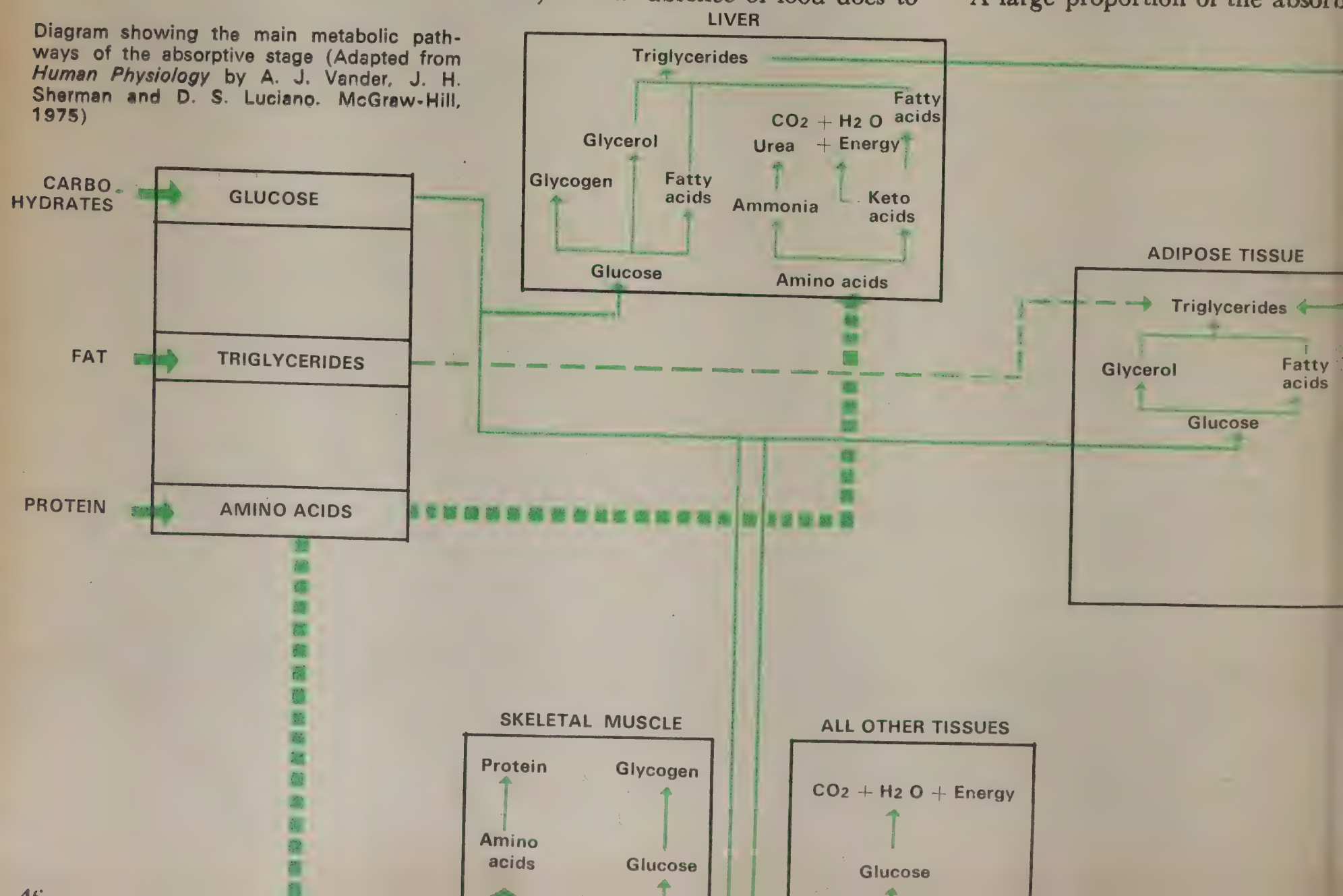
	Normal kg	Percentage	After starvatio kg
Protein	11·5	17·75	8·5
Fat	9·0	13·80	2·5
Carbohydrate	0·5	0·75	0·3
Water			
extracellular	15·0	61·60	15·0
intracellular	25·0		19·0
minerals	4·0	6·10	3·5
Total	65 kg	100	48·8 kg

- The obvious alteration is the almost total disappearance of fat.
- In a fasting person, it appears, vitamin deficiency is not felt.
- Among the minerals the loss of intracellular water reduces the potassium conter of the body.
- Only in extreme cases is the skeleton affected.

Before we go on to analyse what absence of food does to the body, let us take a brief look how the body absorbs its essen nutrients from ingested food. average meal contains approxima 65 per cent carbohydrate, 25 per c protein and 10 per cent fat. Th enter the blood and lymph from gastrointestinal tract — the car hydrate as monosaccharides, the p tein as amino acids and the fat triglycerides and fatty acids, w some glycerol. The carbohydrate a protein go on to the liver via the blo stream, while the fat droplets directly into the lymph.

A large proportion of the absorb

Diagram showing the main metabolic pathways of the absorptive stage (Adapted from *Human Physiology* by A. J. Vander, J. H. Sherman and D. S. Luciano. McGraw-Hill, 1975)



rbohydrate goes into the liver where gets converted into glycogen. The ycogen is, in turn, broken down into ucose or transformed into fatty acids hich go on to produce triglycerides. small proportion of the fat synthe-ed in the liver is stored here, but a ge portion goes into the adipose sue cells via the blood stream. Part the glucose that enters the blood-eam directly gets deposited as fat the adipose tissue cells, part is posited in the skeletal muscles and ner tissues, and part goes into rious body cells to be oxidised into rbon dioxide and water and pro-ce the requisite energy.

The amino acids enter the liver well as other body tissue. In the er, they are converted into keto ds after removal of ammonia (the mmonia is converted into urea and the blood stream gets excreted by kidneys). The keto acids are idised in the liver into carbon di-ide and water and produce energy. course, part of the keto acids can t converted into triglycerides, too.

It is important to remember that t all amino acids entering the body sues are stored as protein; excess mino acids are converted into car-hydrate or fat.

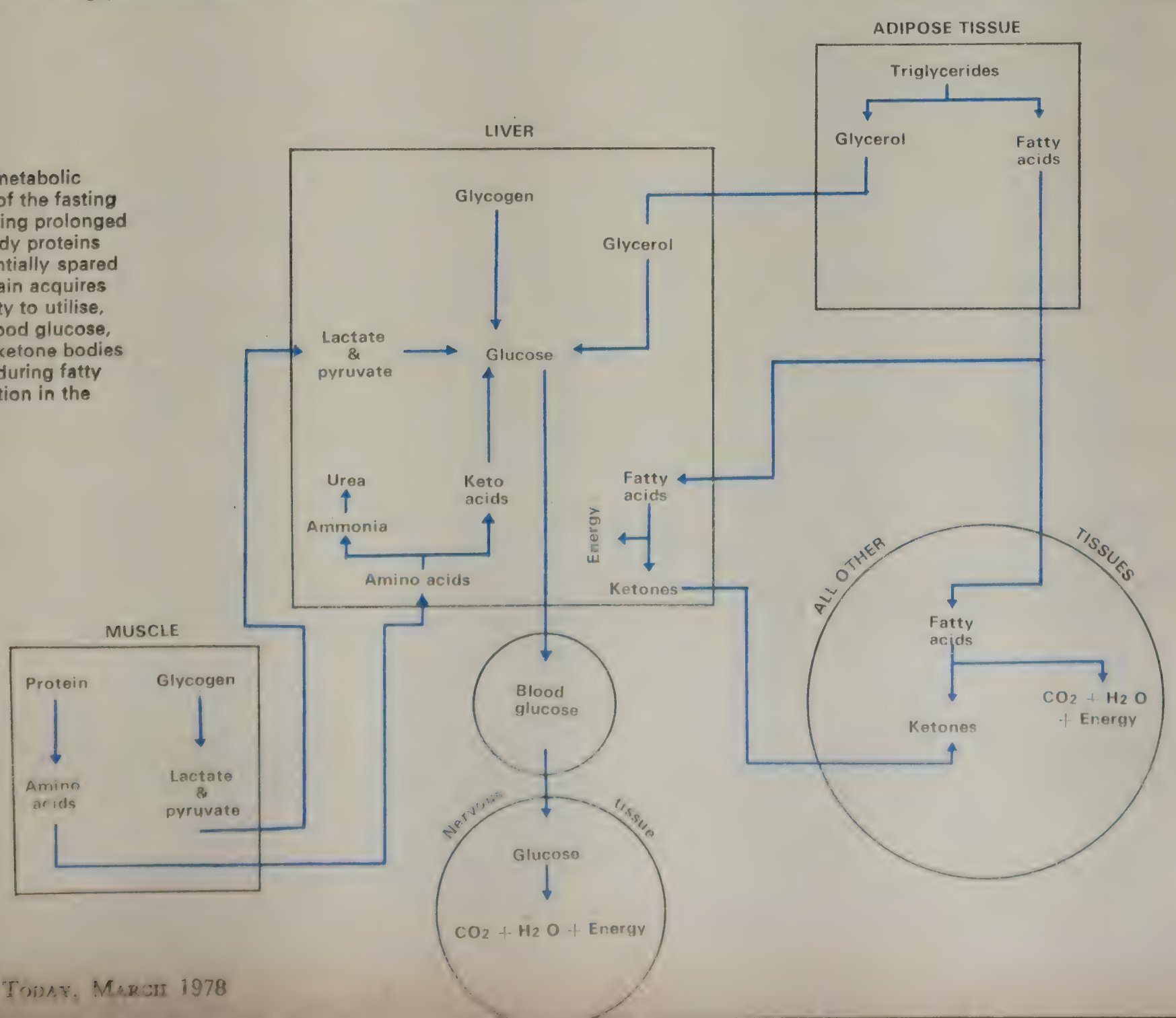
The fat that enters the lymph is sorbed as triglycerides and is de-posited in adipose tissue for storage. Thus, the fat in adipose tissue cells comes from ingested fat, from glucose breakdown in the liver as well as from glucose breakdown in the adi-pose tissue itself.

Glucose is the body's major energy source during the absorptive stage. And the most important user of glucose is the brain — about two-thirds of the total glucose in circula-tion in the body. The nervous system, too, is an obligatory glucose-user; it cannot obtain energy from any other substrate than glucose. Now, as absor-ption (via food ingestion) ceases, the blood glucose level drops. What happens then?

To maintain the blood sugar (glucose) level in the absence of fresh nourishment, the body first breaks down glycogen stored in the liver. The blood sugar level is kept constant by two pancreatic hormones: insulin and glucagon. The insulin level is high when food is being absorbed; the hormone promotes synthesis of proteins, glycogen and triglycerides as well as inhibits their breakdown. Thus, in the absorptive phase, excess nourishment is laid down as reserve under the influence of insulin: amino acids get converted to proteins, and carbohydrates and fatty acids are converted to glycogen and triglycerides, respectively. The glucagon level during the absorptive period is low, but when the blood sugar level drops, the glucagon level goes up and glycogen is broken down to provide glucose. Later, proteins and subsequently fats are degraded for meeting the energy demands of the body. The glucagon level in blood persistently remains high in fasting people.

The amount of glycogen in the liver is small — just enough to provide about 400 Calories of energy. (The body requires 1,500 to 3,000 Calories of energy per day.) Thus, the liver store is not sufficient for more than a few hours. Actually, it isn't even sufficient for the overnight fast. And then, not all the glycogen in the liver can be drawn upon. Part of it is stored exclusively for emergency needs, such as severe stress. Thus, during a prolonged fast, most of the body's energy requirement is supplied by proteins and fats.

The skeletal muscle glycogen and protein form the second line of defence. When the available glyco-gen in the liver has been drained, skeletal muscle glycogen is broken down into amino acids which are converted to glucose by the liver (in the initial stages of fasting) and



e main metabolic hways of the fasting ase. During prolonged ting, body proteins substantially spared d the brain acquires capacity to utilise, ides blood glucose, blood ketone bodies oduced during fatty d oxidation in the er

by the liver and kidney to a greater extent (as fasting progresses). The glycogen in the muscle is degraded to lactate and pyruvate and sent to the liver to produce glucose. However, the protein cannot be used indefinitely. The body does not have that much protein to spare. At the initial rate of expenditure, the entire amount of protein in the body — if it could be used — could not keep us alive for more than three weeks of starvation. Nevertheless, small amounts of proteins are lost continuously throughout the fasting period, but never completely eliminated. As the protein breakdown pace goes down, less nitrogen needs to be excreted; hence urine production drops. If the fasting person does not sweat much, one cup of water is enough to maintain the water balance in the body. At first, nitrogen is expelled as urea and later on as ammonia. This serves two purposes: (*i*) the energy normally required for urea synthesis is conserved, and (*ii*) ammonia being alkaline helps to neutralise the acidity (of the urine) brought about by fasting. (The urine becomes acidic due to the formation of ketone bodies produced by triglyceride degradation.)

Survival becomes difficult if the body loses more than 50 per cent of its proteins. The next available source of energy is fat. Fat is stored as triglycerides in the adipose tissues under the skin and surrounding the internal organs. The subcutaneous adipose tissue acts as an insulation against cold and around the organs it acts as a protective cushion. An average adult body contains about 15 per cent fat by weight; in men the fat content is lower and in wo it is higher.

Fat is a more economical Gram for gram, it yields more en (nine Calories) than either pr (two Cals) or carbohydrate (one Also, its storage does not need water. (One gram of pure protei carbohydrate yields about 4 Calo but in the body, they are stored water; one gram of glycogen b three to four grams of water and gram of protein binds one gra water. That is why there is a dilu of energy yield.)

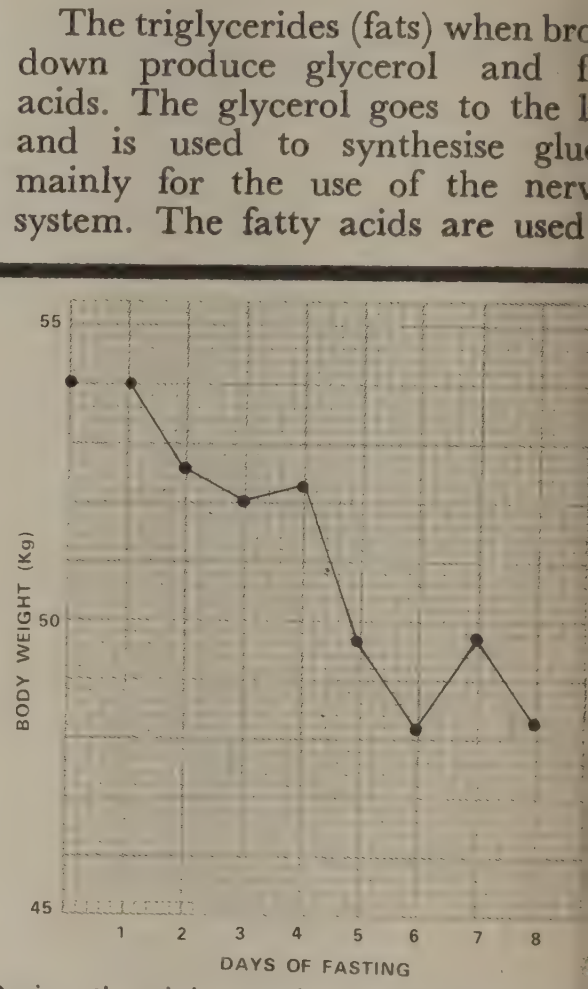
The triglycerides (fats) when bro down produce glycerol and f acids. The glycerol goes to the l and is used to synthesise glu mainly for the use of the nerv system. The fatty acids are used

A STUDY ON PHYSIOLOGICAL CHANGES DURING FASTING IN JAINS

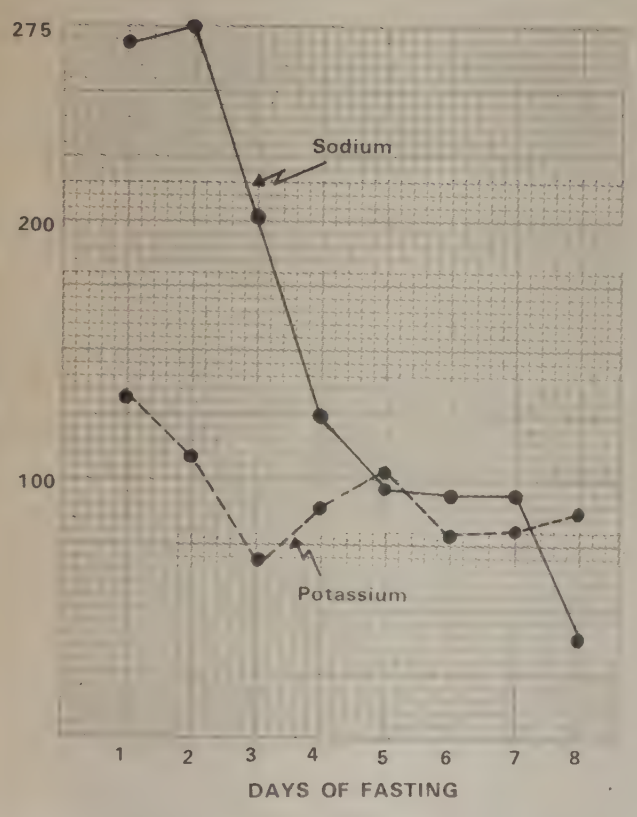
During *Paryushana*, a religious celebration of eight days (sometime in August), the Jains undertake fasts. The number of days of fasting can vary from person to person, but all fasts must end on the last day of the *Paryushana*; which means, someone wishing to fast longer than eight days must start the fast earlier.

The author has conducted a study of six fasting Jains for eight-day fast periods during which only boiled water was taken. Five were men and one was a woman and their ages varied from 17 to 65 years. Each day during the study period, the subjects' body weight, blood pressure, body temperature, pulse, etc were measured. Also, 24-hour urine samples were collected and analysed for the following parameters: 1) sodium (Na) and potassium (k) electrolytes, 2) creatinine, 3) ammonia-nitrogen and urea-nitrogen, 4) total nitrogen, 5) vitamins B_1, B_2 & C, and 6) N'MN excretory product of vitamin niacin. Some of the results are shown here graphically.

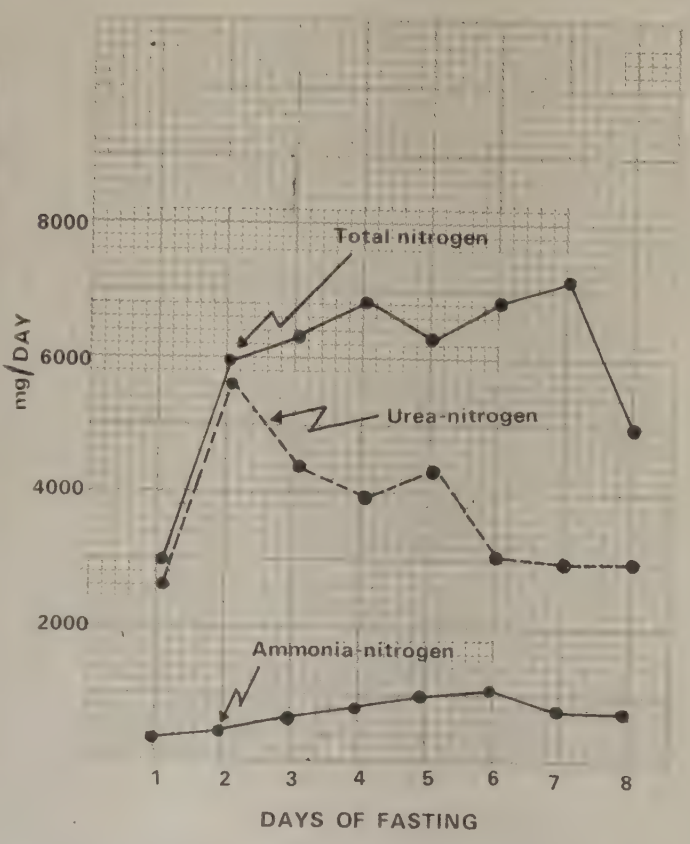
K.M.



During the eight-day fast, weight loss was nine per cent. Average weight loss was 0·66 kg/day (some fluctuations might be due to water intake)

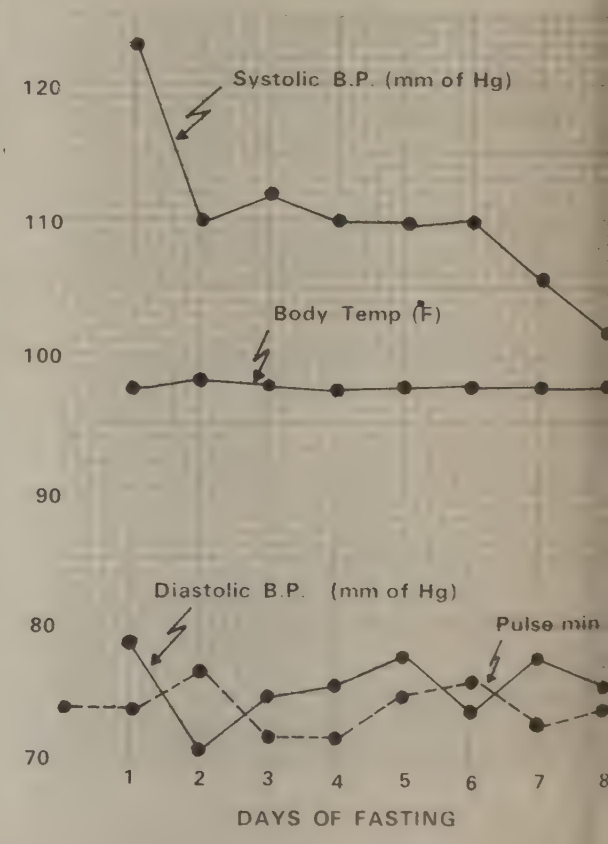


As a result of the fast, both sodium and potassium content decreased, though sodium depletion was more rapid — about 70 per cent in eight days — compared with potassium depletion of 35 per cent. So sodium/potassium ratio in urine changed from 2 : 1 to 1 : 2. This change was due to ketoacidosis



Total nitrogen excretion increased by 66 per cent and ammonia-nitrogen excretion increased by 140 per cent. Urea-nitrogen initially increased and then decreased, as the site of deamination changed from the liver to the kidney

■ The levels of various vitamins did not show any appreciable change.



There was no significant change in pulse rate, body temperature and diastolic blood pressure, though systolic pressure showed a decrease by about 17 per cent

e production of energy. Normal tabolism of the fatty acids does t produce ketone bodies; it is a ponse to the decrease of glucose pply in starvation. The fatty acids e oxidised in the liver to acetoacetic d which is carried by blood to the rious organs to be used as fuel. etoacetic acid yields acetone and tahydroxy butyric acid which are idised to carbon dioxide and water yield energy. They are used by actically all tissues except the rvous system. O. E. Owen and workers (1967) proved that the ain which appears to be an ligate glucose-user begins to use tone bodies when their level in ood is high enough. This is an aptation for conserving protein. Earlier, it was believed that only e liver could synthesise glucose. has now been found that the dney cortex, too, is capable of a nilar activity. In fact, by the sixth eek of fasting, the kidney synthesises ore glucose from amino acids than e liver does. In doing this the dney produces ammonia necessary maintain the acid-base homeostasis the body. The decline of glyconeo-nesis (new formation of glucose om protein) in the liver is attri-ted to the fall in alanine level the plasma; alanine is the chief bstrate used by the liver.

Ketone body production is responsi-e for acidosis in fasting people. cidosis can be controlled by giving 0 g of glucose per day: this is done therapeutic fasting for controlling esity. The acetone produced due to tosis lends a characteristic odour to e person's breath.

How long can a rson go without food? This depends several factors like the individual's alth, age, size, climatic conditions, c. However, a healthy adult can sily survive starvation for 14 days ithout any permanent adverse fects. Of course, during this period fast, his physical efficiency is greatly duced. (A reduction in physical ficiency has been noticed among the Muslims during the month of Rama-an though they eat at night. This is tributed to inadequate sleep at ght and the lack of water by day.) hus, food comes fairly low on the t of survival rations in emergency scue packages and in natural cala-ities like floods and earthquakes. he important items here are drinking ater and adequate protection against e environment.

During the initial stages of fasting, e person loses weight rapidly. This due to the burning off of glycogen d also protein. Now, both these are stored bound with water; when they are used up by the body, the water is expelled as urine. In a carbohydrate-restricted diet, it was found, a man lost about 1·5 kg in three days due to the loss of water. The secret of the near-miraculous results of the instant reducing diets is just this: control the carbohydrate in your diet and you're light. But this rapid rate of weight loss declines as the water loss is soon checked and in emaciated individuals the extracellular water might actually increase.

Weight loss due to starvation can produce a poser when looked at from the cellular angle. Do the cells shrink in size or do they get reduced in number? Animal studies point to the latter, though convincing human studies are yet to be done. One experimental observation on record is the work done by Jules Hirsch of Rockefeller University in the USA. A group of obese adults were fed only 600 Calories a day and had lost about 50 kg of bodyweight. Hirsch aspirated their fatty tissues by hypodermic needle and found the cells had shrunk almost by half.

An average person can lose up to 25 per cent of his bodyweight without any adverse effect. An obese person can lose more. However, there are instances of fasting — under medical supervision — where the loss in weight was nearly 50 per cent. Such a drastic loss is always dangerous and can be fatal.

Many deaths are attributed to starvation. However, investigations show that in all these cases, the primary killer was some pre-existing medical condition. Lack of nutrition only helped to aggravate the condition. There has been one case of death primarily due to starvation. A 20-year-old girl (in the General Hospital, Southampton, England) undertook starvation diet. She lost nearly 50 per cent of her weight. On the ninth day after feeding began, she died of ventricular fibrillation. Autopsy showed that she had used up not only the fat tissue but a good amount of the lean tissue of her body. However, there is no specific level of emaciation at which death occurs.

All parts of the body do not waste away uniformly while fasting. Both obese and non-obese persons lose four per cent of their fat initially. In the obese, the remaining fat has a half-life period of

Semi-starvation

This is one case where "half a loaf being better than no loaf" is not entirely true. For one, 'fasting' is usually voluntary and then the hunger sensation is killed by the fourth day. But in the semi-starved conditions that prevail during famines, the mind becomes preoccupied with the thought of eating: "When and where will the next meal come from?". Moral standards fall and the incidence of crime — murder, looting, robbery and sometimes even cannibalism —increases.

If a person gets less than 1,600 Calories of food per day, he begins to lose weight. By the second or third week he loses about 25 per cent of his original body weight. After this, the body reaches a more or less steady state. If the diet is further reduced, emaciation sets in. The person becomes lethargic, the pulse rate reduces, blood pressure falls and the heart may be atrophied. The person's emotions get dulled and the mind is dominated by a desire for food. If an epidemic erupts during a famine, the death toll can be sky-high.

In an article published in the *Scientific American* (October 1971), V. R. Young and N. S. Scrimshaw cite a curious phenomenon associated with semi-starvation. They say, a semi-starved person's survival time may actually be shortened if he tries to live on a diet of carbohydrates alone without any proteins. In children, the effect can be the disease known as kwashiorkor. This is the most vivid result of protein deficiency, in which besides apathy and loss of appetite, the victim shows oedema and changes in skin and hair.

Starvation in children results in permanent stunting. No amount of nutrition later on can remedy this.

S.

Kwashiorkor victims

204 days and in the non-obese 127 days. (Men lose more weight than women and it has also been found that women can cope better than men: fewer women than men die during famines.) Tissues like the adipose tissue, the liver, and the skeletal muscles which can be regenerated are sacrificed to preserve the vital organs. In extreme cases, even the vital organs begin to be affected but the brain is always well cared for; if it lacks nutrition for even a short time (few minutes), damage, coma and finally death results.

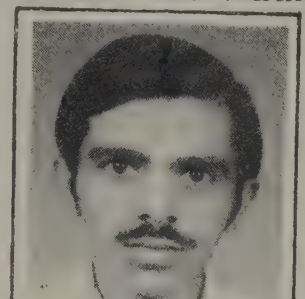
Tissue wasting is an obvious outcome of fasting. The skin becomes loose, the hair is dry and lustreless, and the eyes appear abnormally large since the orbital muscles surrounding it shrink. As the subcutaneous fat is used up, the person becomes more sensitive to cold. (This sensitivity may also be increased by the poor blood circulation. The circulation to the extremities is curbed in an effort to conserve heat and also to lessen the burden on the heart. Often the extremities of the limbs of the fasting person appear blue.) There is a marked wasting away of skeletal muscle and slowly the other muscles are affected. During a prolonged fast, the heart is also affected. An autopsy study of hearts of starvation victims of the 1966-67 Bihar famine found a great degree of cardiac atrophy. In a healthy adult, the heart weighs about 350 g. In an 1889 study, 459 autopsies of Indian famine victims showed that in 45 per cent of them the heart weighed only 170 g. If atrophy is severe, failure in circulation leads to death.

The blood pressure drops and the pulse rate falls during prolonged fasting to 40 per minute. (Normal pulse rate is 70/min.) Mild anaemia and amenorrhoea are common.

Even the digestive organs are affected. Secretion of digestive juices almost grinds to a halt within the first four days of starvation to conserve protein. Salivation is reduced and this leads to bad breath. The mucus layer and muscular walls of the small intestines get atrophied and the gut loses its power of absorption. Therefore, the fasting person has to break his fast gently with small amounts of bland and preferably slightly sour foods. Gradual refeeding stimulates the digestion process. Overfeeding and heavy foods, particularly highly spiced foods, can even kill the person. This has been noticed in several starvation cases during famine. Autopsy studies have shown that the small intestine walls become so thin that if any food were eaten just before death it could be seen through the v

The water content of the body not alter much; in fact, there is an increase in the extracellular w which causes oedema.

However, we have seen how thr adaptations the body can survive f long periods of want. The abili withstand long foodless periods m have helped our hunter-food-gath ancestors to tide over the lean peri some think it may have been evolutionary tool to weed out weaker individuals.



Kishor P. Mistry did his MSc from M. S. Unive Baroda, and is n researcher on i nutrition at the De ment of Clinical chemistry of the Ba Medical College UGC fellowship.

Recommends reading: **1.** Bloom, W. L. Fasting: an introduction to the treatme obesity. *Met. Clin. & Expt.*, 8 : 214. **2.** Ha 1966. Total fasting up to 249 days. *L* 1128-1129. **3.** Owen, G. E. *et al.* Art published on various body metabol during fasting in *J. Clin. Invest* — 46: 1 1595 (1967), 48: 574-583 (1969) and 50:1 1544 (1971). **4.** Cahill, C. E. 1970. Starva in man. *New Eng. J. Med.*, 282: 12, 668- **5.** Young, V. R. & Scrimshaw, N. S. 1 The physiology of starvation. *Scientific Amer* 225, 14-22 (October).

BRAIN TEASERS

THE GREAT BANK ROBBERY : The bank robbery, which involved a large number of currency notes, created a sensation in the city.

After dividing the swag among themselves, the robbers found an interesting relation between their respective shares. It was found that Ramesh got one-third of Iqbal's share, one-sixth of Robert's and one-eighth of Dileep's. The youngest of them got Rs. 99,999 more than the eldest.

Who were the youngest and the eldest? What were their shares?

S. N. BABLESHW

(Solution next month)

Solution to last month's Brain Teaser

God's game

The new Destroyer cannot be Shiva, Ganesh or Vishnu; so Brahma is the Destroyer. Shiva with Garuda is not the Protector, Destroyer or the Lord of Obstacles; so he is the Creator, making Ganesh the Protector. If he (Protector) takes the Swan, Brahma wants the Bull; but Brahma has got the Rat already. So Ganesh cannot have the Swan and he is left with the Bull. Then Vishnu takes the Swan. The entire new set-up is:

Name	Vocation	Vehicles
Shiva	Creator	Garuda
Brahma	Destroyer	Rat
Vishnu	Obstacles	Swan
Ganesh	Protector	Bull

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Date: 28th February 1978

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Signature of Publisher

Question bank—how not to ask questions

UESTION BANK BOOK SERIES—
2 PHYSICS, Association of Indian
niversities, New Delhi, 1977, 473
, Rs. 20·00

"THE crippling effect of external examinations on the quality of work in higher education so great that examination reform has ecome crucial to all progress, and it as to go hand in hand with the im-rovement in teaching" declared the ducation Commission Report (1966) reproduced in the University Grants ommission document on Examina-on Reform (New Delhi, 1973). The bject of examinations has come into ominence in Indian education in cent years.

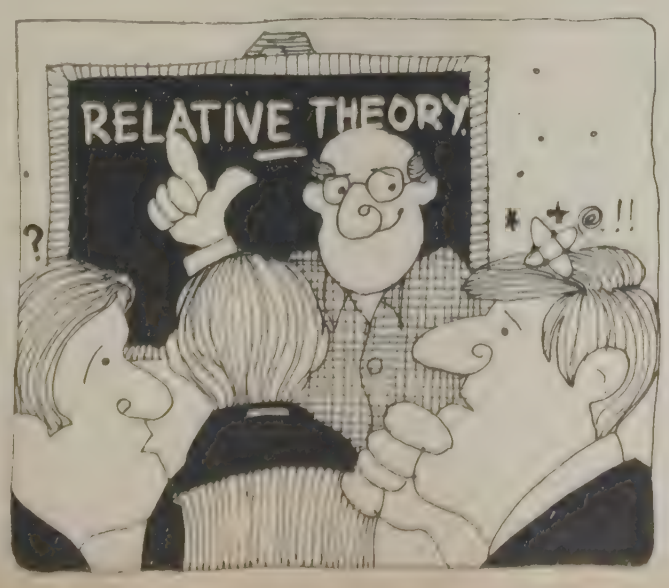
Examination is the process by which dgements about the educational hievements of students are formed. has many purposes, one of which is e marking of students for promotion. ut in the Indian educational set-up day, it is used solely for this latter rpose. It is hardly ever considered an effective means of testing the ficacy of the teaching and learning ocesses.

Everyone connected with education all levels, from the UGC to local amination boards, today feels at it is about time we overhauled r examination system so that it ings forth the best that education s to offer to students in India. These e fine sentiments, but looking ound at the educational scene in dia, one feels that precious little has en done, besides bringing out docu-ents like *Examination Reform* (UGC) d the series of which the present lume *Question Bank—02 Physics* is a art.

One of the aspects of examination form seems to be the preparation nd distribution of question banks to achers and students. It is stipulated hat the examination questions should e set from this question bank. And he idea of the question bank has been pelled out in Appendix IV of *Examination Reform*. It has been evolved o eliminate a number of glaring efects in our examination system. ome of these are: (1) question papers, hich are often prepared in a short me by people who do not teach the ubject are defective; (2) there is no dequate participation of teachers in he process of organising and conducting examinations; and (3) there is an element of surprise for the students when they see a question paper.

Though the idea of the question bank is not new, the idea of making it available to students seems to be Indian in origin. According to my information, one of the most comprehensive question banks exists with the Educational Testing Center (ETS), Princeton, USA, which holds world-wide examinations like the GRE (Graduate Record Examination). This question bank is collected, tested, classified, etc over a number of years and stored at Princeton. It is continuously changed and improved. It is from this question bank that a large part of the examination like the GRE is set. ETS does not supply it to students, but issues from time to time informative booklets with illustrative questions for the information of the students who appear for their examinations. This, in my opinion, is sufficient to remove the element of surprise. The question bank must be at the disposal of the teacher to facilitate drawing up a well-designed question paper. If it is made available to the students as well, it should be used as a learning aid and the teacher should not be asked to set an examination paper from it.

The book under review, published by the Association of Indian Universities (AIU), is a massive work. It contains 4,535 questions in physics mainly at the undergraduate level. The questions in this book, according to its sponsors, represent the "distilled essence" of the teaching skills and dedicated work put in by almost a thousand teachers. The secretary of the AIU, Dr. Amrik Singh, also states that "after all, no other step is likely to have more decisive effect on instruction in the classroom than remodelling the kind of questions that are asked at the time of the examination". However, the book belies this aim. It abounds in the very kind of questions that it seeks to remodel. A sample scrutiny of the questions/items on the topic of the "Relative Theory" will suffice to illustrate.



What is this topic of "Relative Theory"? One understands relative motion, relative velocity and the like, but who has heard of the "Relative Theory"? This is the name given by the AIU workshops to the "Theory of Relativity"! There are 36 questions/items on this topic. Qs. 22, 33, 35 testing for knowledge of universals reads: "write notes on . . ." In particular, Q. 35 is "write notes on the General Theory of Relativity"! Further, Q. 23, which is supposed to test unique communication reads: "Give an account of the Special Theory of Relativity"! These are supposed to be short-answer (15 minutes and 20 minutes) questions carrying 5 marks. On the other hand, on page 53, Q. 575 asks, "write *short* notes on the Universal Law of Gravitation" and carries 6 marks. Notes carry 5 marks while *short* notes carry 6 marks! These are the kinds of questions that should *never* be asked. Students can prepare by rote ready-made answers to such questions and no distinction can be made between students who have seriously studied and who have not. And examiners may differ in assessing a given single answer to such a question from 20 per cent to as much as 70 per cent and the assessment becomes a gamble.

A question should set a clear task before the student. It should seek out what a student has understood, what is his grasp, what is his power of application and not what he can reproduce from his memorised knowledge. Out of the 36 questions, 15, or 42 per cent, are bookish and memory tests, six one-minute items are trivial, another six call for substitution in a standard formula and the remaining nine are tolerable. There seems to be hardly any question which testifies to the "distilled essence" of the teaching skills, etc. I have no doubt that a number of dedicated teachers had participated in this exercise, but for some strange reasons, what they have brought out is not a really good document.

If one delves further into this massive book, one is in for greater

disappointment. Qs. 67 and 68 are meaningless, and so is Q. 124. Q. 137 is, "Write a note on Plasma"! True-false and fill-in-the-blank type are bad questions. In True-false–I don't know type questions, is "I don't know" to be the right answer? Some fill-in-the-blank questions are so ambiguous that there can be more than one answer. For instance, Q. 2976 can be answered without filling anything in the blank provided and yet be meaningful! In a number of multiple choice questions, there is more than one possible answer. For instance, look at Q. 517 which is the same as Q. 539. Electro-dynamics and thermoelectricity is a curious combination. However, seeing some good questions, though few and far between, one feels that all is not lost. Qs. 3018 and 3019, for instance, are good "notes" questions.

In the end, one feels sad that well-meaning and sincere efforts on the part of a large number of teachers who took part in the workshops could not produce a document of a really high standard. The book needs a thorough revision, a large part of it needs to be scrapped and another part recast before it is given to teachers and students.

R. V. KAMATH

Chemistry for pre-degree students

PRINCIPLES OF CHEMISTRY by A. N. Sharma and Y. D. Jigyasu, Kalyani Publishers, Ludhiana, 1977, pp. 783, Rs. 25·00

THE book is primarily meant for the pre-engineering, pre-medical and B Sc Part I students of the Punjab, Guru Nanak Dev, Punjabi, Kurukshetra and Himachal Pradesh Universities. It contains 30 chapters, of which the first 13 deal with the fundamental principles of chemistry and the rest with the chemistry of organic compounds. The language of the book is simple and the style easy, though at some places the treatment of the subject tends to become somewhat sketchy. An added feature of the book is the question exercises and quiz, with answers, at the end of each chapter. The book is amply illustrated and the diagrams are generally well-drawn. The inclusion of chapters on the isolation, purification and analysis of organic compounds as well as the last chapter on organic conversions is commendable.

The book has several printing errors, for example, on p. 31 ("I Brolie's equation" instead of "Broglie's equation"), p. 299 ("diffsion" instead of "diffusion"), p. 4 ("lathanide" instead of "lanthnide"), p. 446 ("littium" instead "lithium"), and p. 768 ("inidazol instead of "imidazole"). The wo "furan" is wrongly spelt througho the book as "furane". In ma places, the circles inside the rin indicating their aromatic nature a omitted. The structure on p. 7 indicating "imiazole" is wrong a it is not clear what compound t authors have in mind. The manner drawing rings at various places (p. 52 specially of heterocyclic compoun where the hetero atom is show outside the ring, is erroneous and likely to cause confusion.

Despite these, the availability of lot of material at one place and th simplicity of the language shou make the book useful to pre-degr students of chemistry, specially tho who have been taught in their mothe tongue and are not at ease wit English.

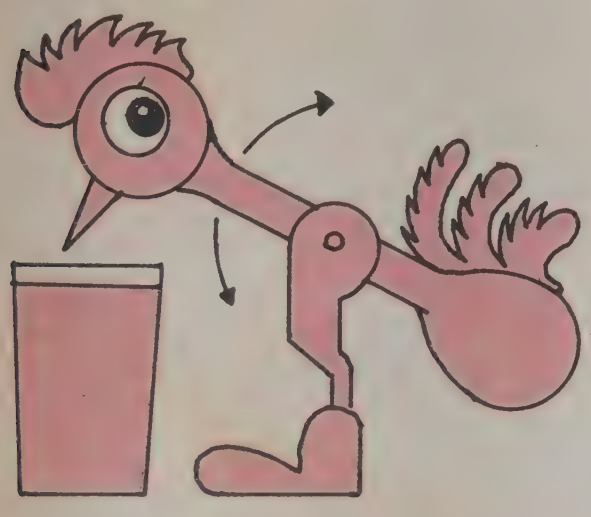
J. R. MERCHAN

[Dr. Merchant is Professor of Organic Chemi try at the Institute of Science, Bombay.]

TELL US WHY...

. . . the dunking duck rocks continuously

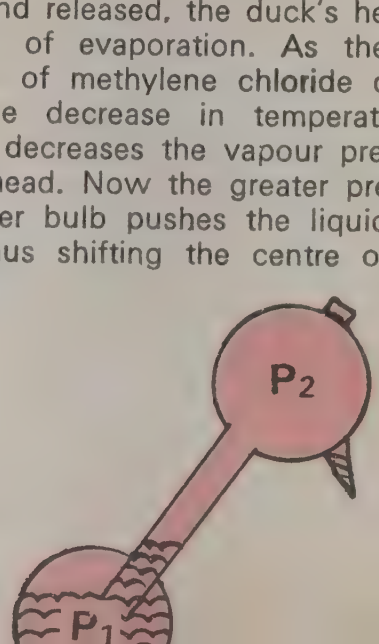
You may have one at home or you may have seen one in shop windows. Give this duck an initial 'drink' and it periodically dips down for more. You must have wondered what gives this toy duck such an insatiable thirst!



The toy itself is rather simple-looking. There are two glass bulbs at the ends of a glass tube 12 to 15 cm long, one making the head, and the other, the rear of the duck. A metal band attached to the glass tube acts as a pivot allowing the bird to rock. Normally, it rests on the frame inclined at about 45°. You start the motion by wetting the 'head' in a glass of water and the bird begins to oscillate, eventually dunking its head again into the water. As long as it keeps getting its head wet, it continues to bob up and down. What makes it go?

Well, actually, the temperature difference between the head and the tail is responsible for the movement of the bird. Let us see, how! The essential construction of the toy is as shown in the diagram below. The lower glass bulb is partially filled with a volatile liquid, for example, methylene chloride. The head and the beak are covered with an absorbent material so that the entire head becomes damp when the beak is wetted. The duck's body contains just the liquid and its vapour and no air. Hence it has vapour at two places, P_1 and P_2.

When the beak is initially dipped in water and released, the duck's head cools because of evaporation. As the vapour pressure of methylene chloride decreases with the decrease in temperature, this cooling decreases the vapour pressure P_2 in the head. Now the greater pressure of the lower bulb pushes the liquid up the tube, thus shifting the centre of gravity towards the head. The device now be comes unstable and the head dips down



What happens now? The lower end o the glass tube projecting into the posterio bulb rises above the level of the remainin liquid. A series of vapour bubbles surge u the tube equalising the pressure and th pushed up liquid runs back to the bas setting the duck right again. Clever geo metry and a selection of the two volume of the vapour provides this mutuall exclusive condition between the hydrosta tic equilibrium and the mechanical equili brium. The evaporation continues as a oscillation between these two equilibriu conditions.

You can make a few interesting studie to verify this physical/chemical process Increase the ventilation — by carefull directing a fan on the duck's head — and you will see that the duck bobs more rapidly. This is because the evaporation is now hastened up. Place a bell-jar over the bird and it will *stop* drinking the water because you have cut off the route of entropy production! You can also make the bird rock, without wetting its beak — you have to gently heat the posterior instead to create the temperature difference. A temperature difference of less than a degree C will push the liquid up the head.

The density of the liquid used and the variation of the liquid's vapour pressure with temperature actually determine the volumes of vapour pressure and the temperature difference required to produce the proper pressure difference.

JAY RAJA

earn while you play—15

B. D. KELKAR
A. V. DESHINGKAR

FOR centuries, both scientists and philosophers had wondered about the nature of thunder nd lightning. Nobody knew the nswer until one day in the 18th entury, Benjamin Franklin, the great merican statesman-scientist, decided o fly a kite. It was an ordinary child's ite really, except that Franklin had ttached a wire spike to it. At the ther end of the string he attached a ey. He released the kite during a hunderstorm, and as a thunderbolt assed overhead, was able to draw a rge electric spark from the key. his, of course, would have been very angerous, but Franklin had wisely eld the key-end of the string with an sulator. Rain had soaked the string nd increased its electrical conducti- ity, and electricity flowed freely down he string and was found to have he same properties as the electricity roduced by friction. (Actually, it was he success of Benjamin Franklin's xperiment that led to the advent of ightning conductors to protect tall uildings.)

It was also Franklin's work that stablished the positive and negative harges in electricity. What are these electrical charges'?

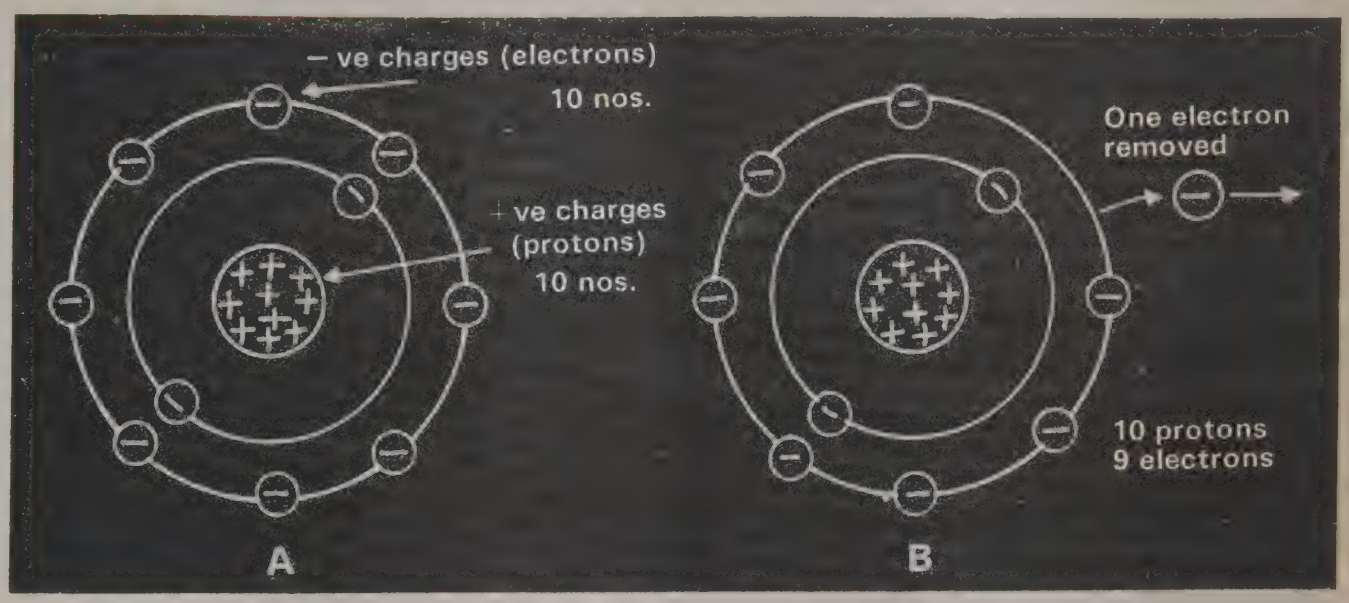
Take a polythene paper bag and ub your palm on it. Bring the bag lose to your skin and move it side- ways slowly. You will find your skin air is attracted towards the paper.

If you place light dust particles or paper pieces on the ground and bring a freshly rubbed paper over it, the pieces will be attracted towards the paper.

Take a hard rubber comb and comb your hair. If your hair is sufficiently dry, you will hear a crackling noise. What causes it? Well, the answer is, when drawn through dry hair, the rubber comb gets charged with electricity and produces the crackling noise due to discharge of the electrical charge. This charge is so great that a tiny spark can actually be seen to jump between the comb and hair in a darkened room.

The electrical charge produced on the polythene paper and on the rubber comb is known as 'static electricity' (or electricity at rest). This phenomenon is observed in many non-metallic materials such as glass, rubber, amber and plastic. These materials produce static electricity when briskly rubbed with either fur or hair.

Fig. 1



Neon atom shown schematically. A: neutral (10 +ve and 10 —ve charges). B: Atom with positive charge

Let's try to understand why bodies become electrified by friction. All substances are made of atoms and molecules. Each atom contains a nucleus having a known amount of positive charge (Fig. 1). This positive charge is due to the presence in the nucleus of a certain number of protons: all protons are alike and have the same mass and positive charge. The number of protons (and hence the amount of +ve charge) in a nucleus changes from substance to substance and decides the properties of the substance. Around every atomic nucleus, there are a number of negatively charged particles known as 'electrons'.

Individual atoms or a large group of atoms and molecules of many substances have an attraction for additional electrons. This attraction for more electrons varies from atom to atom. So, when two different substances are brought into contact, the substance with greater affinity for electrons seizes nearby electrons from the atoms of the other substance. Thus, it acquires a net —ve charge. When a hard rubber comb is rubbed against fur (or hair), the comb gets additional electrons from the fur (or hair) and gets negatively charged, while fur (or hair) loses electrons and gets +vely charged as it donates —ve charge.

On the other hand, a glass rod rubbed with silk cloth gets +vely charged.

This electrical charge is known as electrostatic charge and is present on the surface of the substance until it dissipates in the surrounding air.

Electrostatic attraction

When a substance acquires either +ve or —ve charge, it attracts lightweight substances having the opposite charge. Let's make an "arrow-head indicator" to illustrate the phenomenon of attraction. Cut a small arrow (about 6 to 8 cm long and 1 to 1·5 cm wide) from either thin, dry wood or card paper. Locate its centre of gravity and balance it on a needle point as shown in Fig. 2. Now charge a rubber comb by moving it through your hair and slowly bring it near the arrow-head. The arrow will spin about towards the comb.

Repeat the experiment using a

Attraction

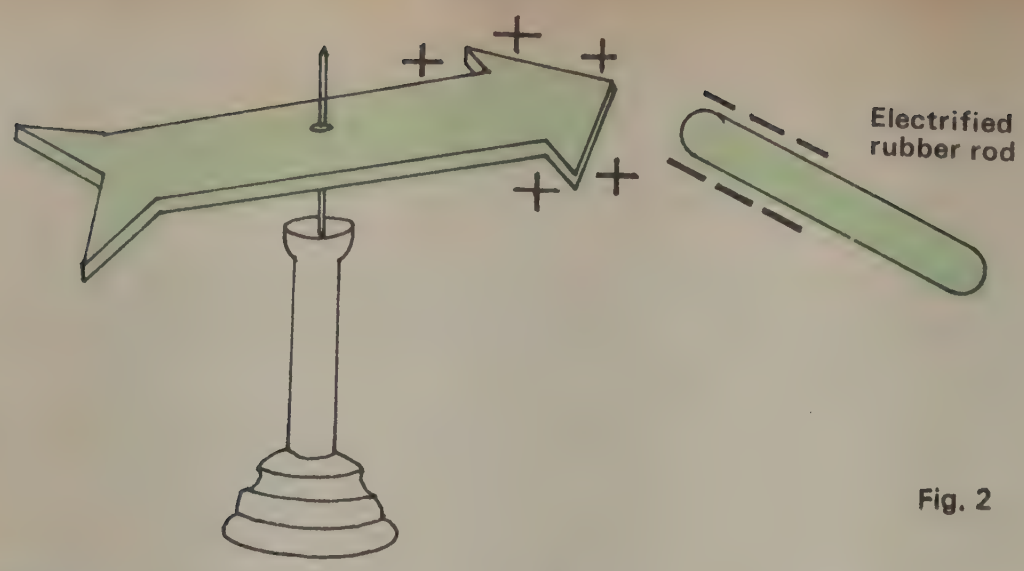
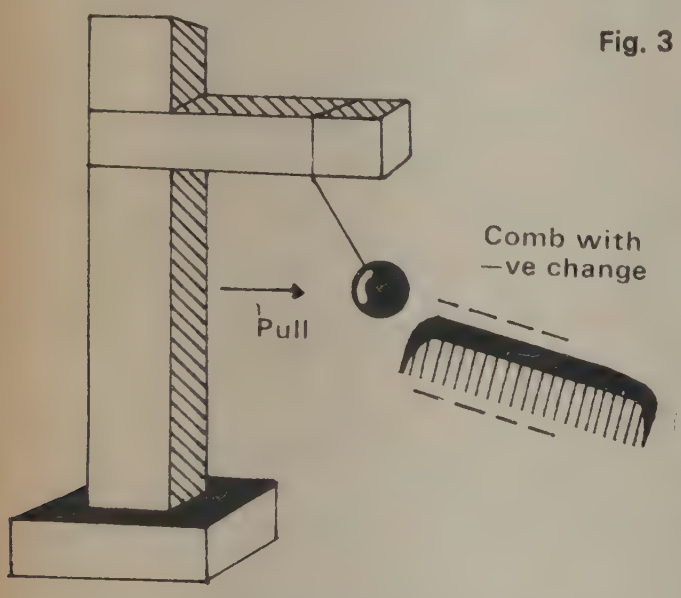


Fig. 2

glass test-tube in place of the comb after you have charged it electrostatically by rubbing with silk. What do you notice?

Another instrument you can make to test the same phenomenon is the " ball indicator ". Take a 20 cm high wooden stand with a wooden base. Hang a light paper or cork ball by a silk thread (Fig. 3). The ball will get attracted towards the charged body.

Fig. 3



Let's have some fun now. Blow up a balloon and rub it with fur. Now hold the balloon against the wall. It will remain stuck for a while! Can you work out why it won't fall?

We have seen earlier that the electrostatic charge is produced on the substances in contact when they acquire electrons. Further, if the substance donates electrons, it gets +vely charged (as it loses electrons) and if it acquires electrons, it gets −vely charged on account of the additional electrons gained.

Let us now perform some experiments to study the behaviour of charged bodies. We need very few materials really: (1) one wooden stand — about 20 to 25 cm high, (2) soft wire to prepare a hook, (3) some thread, (4) two glass rods (or test-tubes), (5) two rubber rods (or combs), (6) silk, and (7) fur.

Prepare a hook for suspending the electrostatically charged body. Hang the hook from the stand as shown in Fig. 4.

Experiment 1: Rub a glass rod with silk and suspend it from the hanger. Take the other glass rod, rub again with silk and bring it close to the suspended rod. The two rods will repel each other (Fig. 4a).

Experiment 2: Repeat the same experiment with the rubber rods now after rubbing them with fur. Again the rods will repel each other (Fig. 4b).

Experiment 3: Take a glass rod and rub it with silk and suspend it from the hanger. Take the rubber rod and rub it with fur. Bring it close to the glass rod slowly. What happens now? The rods are *attracted* towards each other (Fig. 4c). The same thing happens if you interchange the positions of the two rods.

The above three experiments prove what you have already read in your text-book — *like charges repel, wh unlike charges attract each other.*

PROBLEM

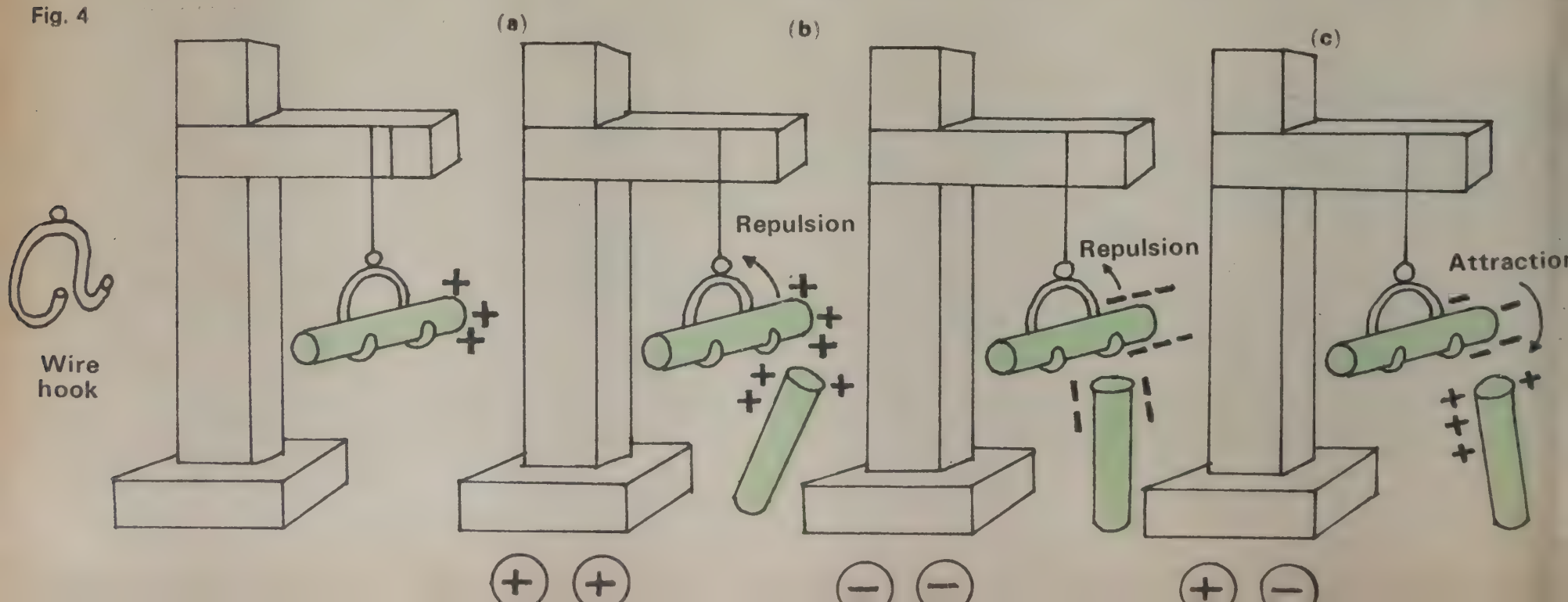
Unroll a cellotape in a dark room and you will find a brief glow along the line where the tape is ripped from the roll. What causes the glow? Does it have any particular colour?

Metal-leaf electroscope

The electroscope an instrument to indicate the electr static charge (either +ve or −v on a body. It's very easy to fabrica an electroscope of your own. You wi need an empty jam bottle with cork lid, a 30-cm-long copper wir and a thin metal foil about 1·2 m wide and 5 cm long.

Prepare a hook out of the coppe wire and insert it through the cor Prepare a spiral head at the othe end. Fold the foil at the centre an mount it on the hook-end of the coppe wire. Use wax to fit the cork li

Fig. 4



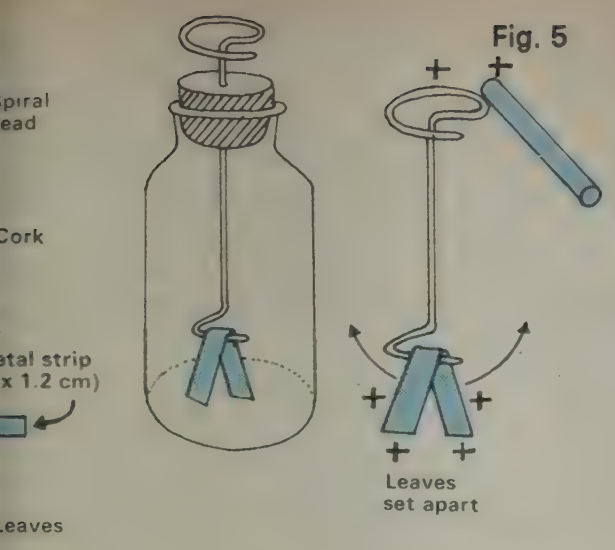


Fig. 5

htly. Your electroscope is ready use (Fig. 5).

Rub a glass rod with silk and bring close to the spiral head of the in-ument. Watch the leaves. Repeat e experiment shown in Fig. 4 with a arged rubber rod. The leaves will *ve* apart as they receive the ' like ' arge from the rod.

Let us take a glass rod and rub it th a silk cloth. The glass rod will +vely charged and the silk cloth ll be —vely charged.

Rub a rubber rod with fur and ng it near the silk cloth. Does the d attract silk? Repeat the experi-ent with uncharged silk. Now, does e silk cloth get attracted towards e rubber rod?

Let's move on to other characteristic of static elec-city. The electrostatic charge can produce the static charge in another bstance in the vicinity. Take a bber (or glass) plate and mount it a table. Rub it briskly with fur ne glass with silk) to produce elec-ostatic charge. Take a metal plate th an attached wooden handle. ow follow these steps (Fig. 6).

Hold the metal plate close to the bber plate without touching it.

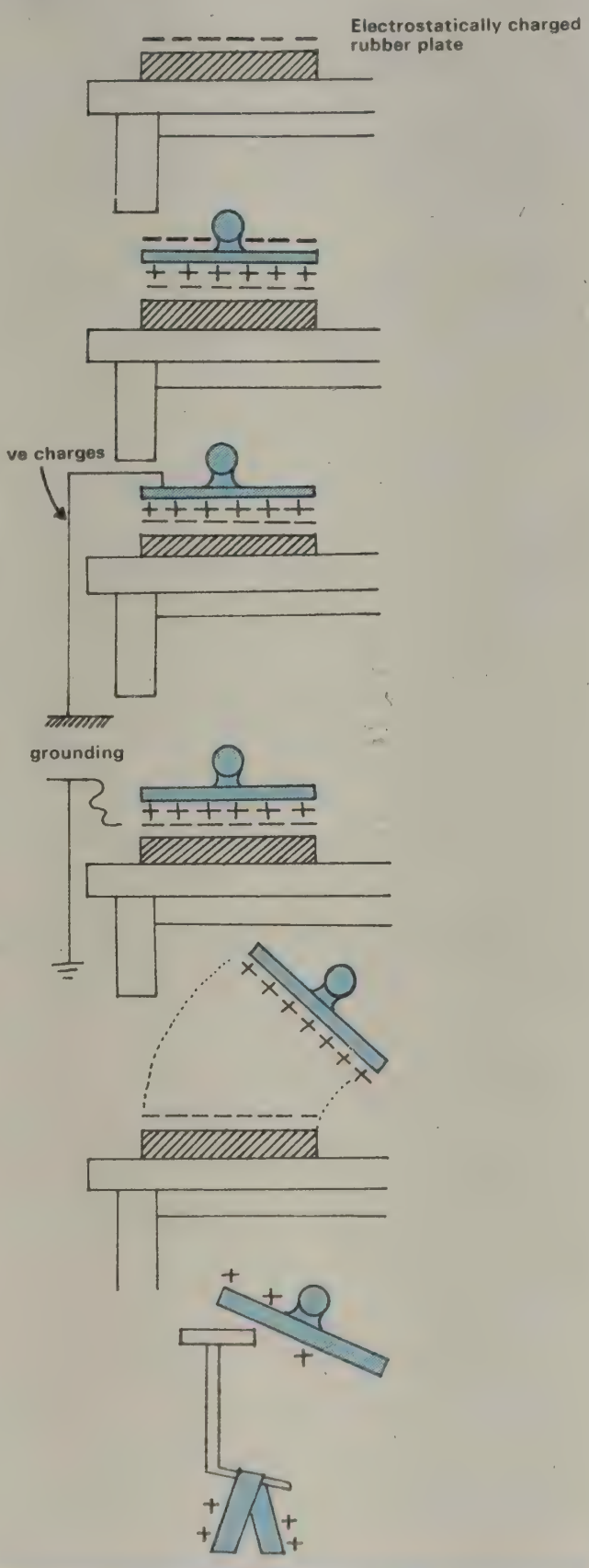
) Ground the top surface either your hand or with a copper wire.

(*iii*) Remove the grounding.

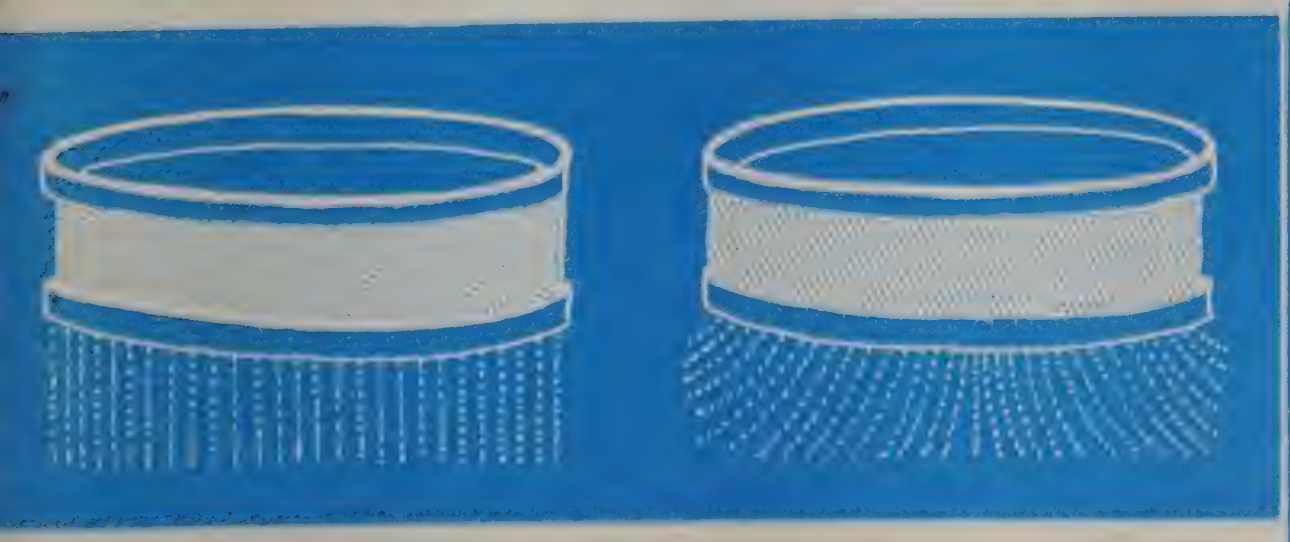
(*iv*) Take the plate away.

(*v*) Touch the plate to the metal leaf electroscope. Note that the leaves of the electroscope will move apart, indicating there is charge on the plate.

Fig. 6

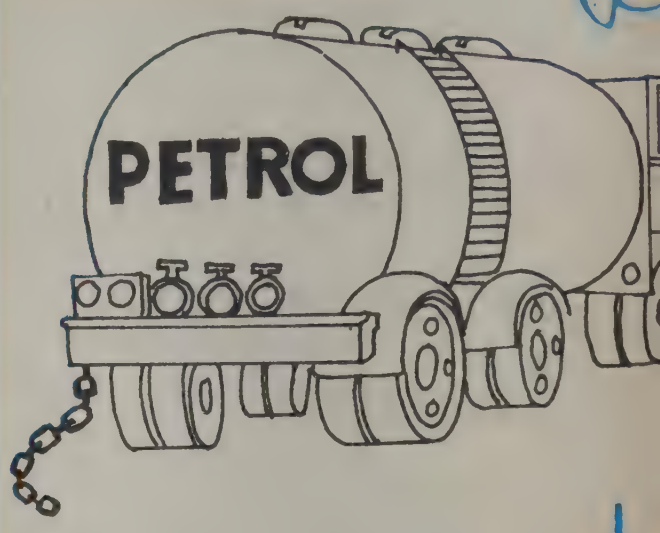


PROBLEM



Your mother is sifting some confectioner's sugar for a cake frosting. Watch the sugar's fall. At first, the sugar will fall straight down. But, gradually, more and more sugar will be thrown to the sides. Why this deflection?

PROBLEM



Petrol tankers on the highways often drag chains along the road. Do you know why?

■ The problems included in this article appear in the fascinating book of physics problems, Jearl Walker's *The Flying Circus of Physics*, published by John Wiley & Sons.

(*vi*) Repeat the experiment several times. Each time you will find the metal plate has a charge.

This is possible only as long as the static charge exists on the rubber plate and is not dissipated into the surrounding air. This is the property of " inducing the static charge " on a substance in close vicinity.

What happens to the static charge on hollow vessels? Get a small metal vessel, an electric wire, your metal electroscope, a glass rod and silk cloth.

Keep the vessel on the table. Rub the glass rod with silk to produce the electrostatic charge. Transfer the charge to the inner surface of the vessel. Connect the inner surface of the vessel to the electroscope. The leaves will not deflect (Fig. 7).

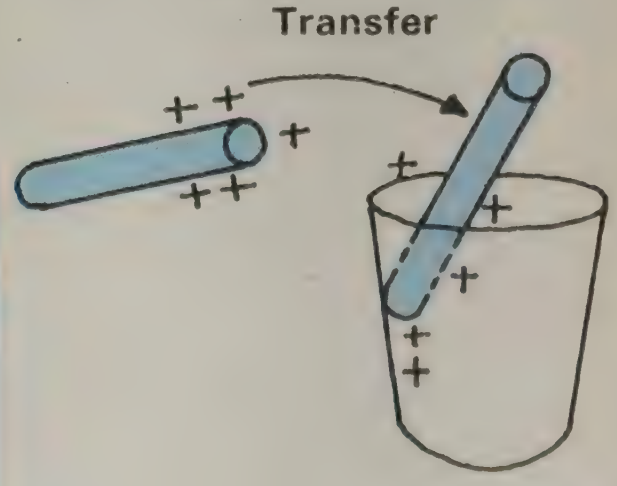
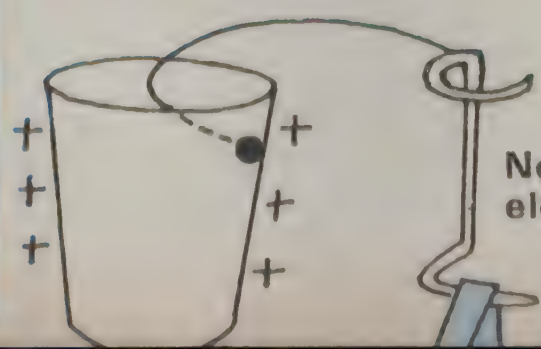


Fig. 7



Again transfer the electrostatic charge to the inner surface and connect the outer surface with the electroscope. Now the leaves will be deflected.

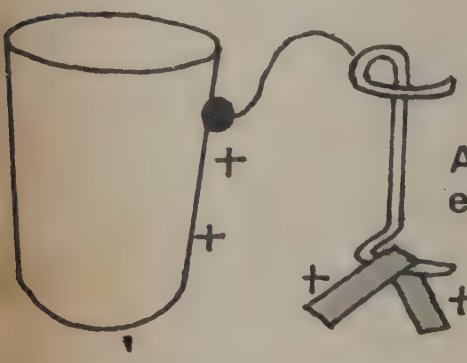


Fig. 8

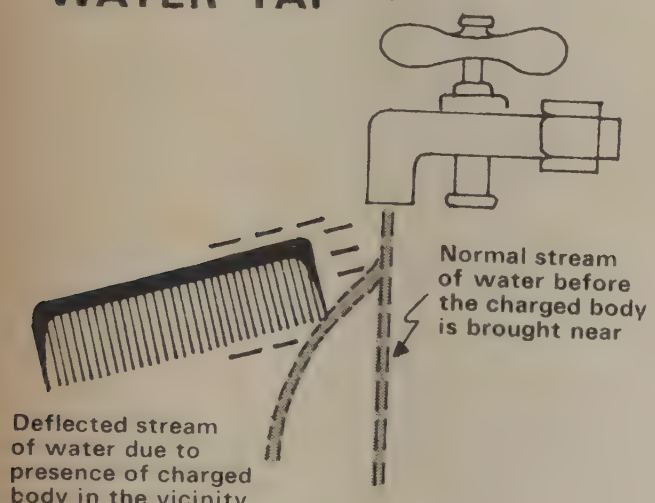
Action of electroscope

What did we prove? We showed that the static charge always appears on the *outer surfaces* of bodies.

Now let's go on to make some interesting toys.

●●

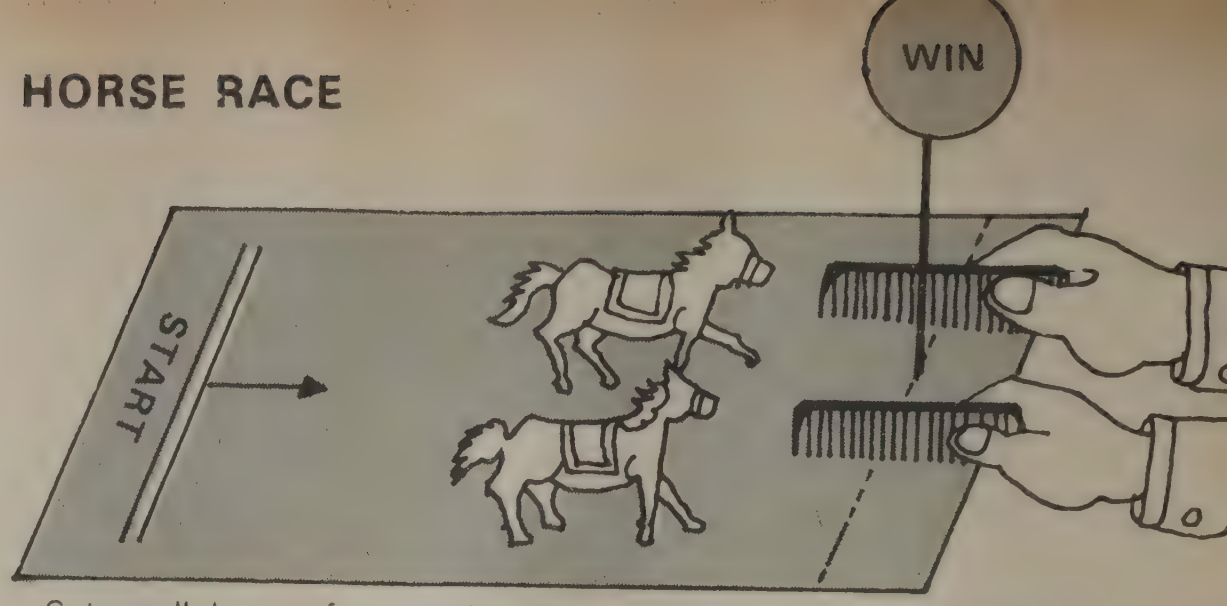
MAGIC WITH WATER TAP



Open the water tap just enough to allow only a very small stream of water to flow. Then take a hard rubber comb and move it through your hair to get it charged. Bring the comb near the stream and observe the deflection. The stream becomes nearly *horizontal,*

If you use a glass rod in place of the comb, what will be the effect?

HORSE RACE



Cut small horses from card paper and either provide a small base to each of them or fold the legs a little to keep them upright.

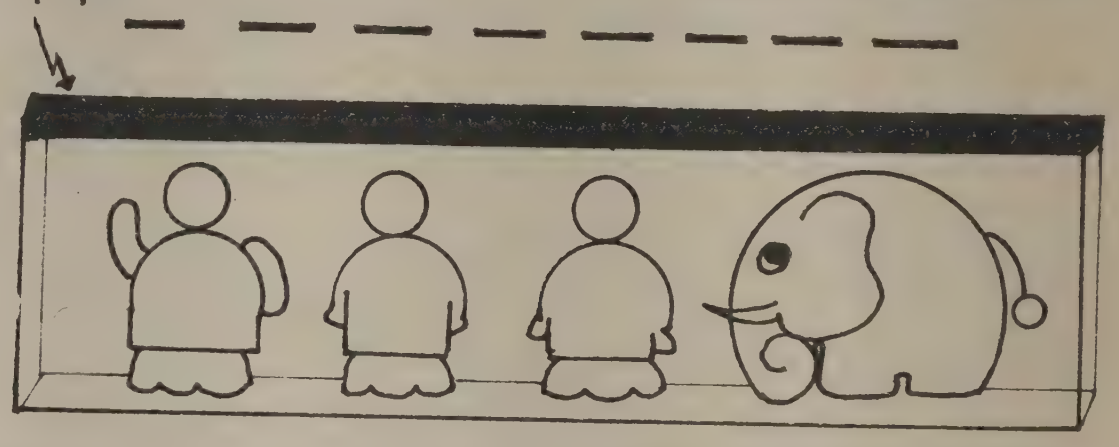
Keep them at start position and be ready with your companion to play the game.

Take hard rubber combs and get them charged by combing your hair. The game is to pull the horses with the force of attraction (that is, without touching or pushing with the combs). You may be allowed to comb for recharging the comb several times.

Remember, you will win the race only if your hair is dry and produces sufficient charge on the comb.

ANTIGRAVITY PEOPLE

Take a small cardboard box and a polythene (or plastic) paper to cover it. Cut small figures out of card paper (or drawing paper) with the bases folded to keep them upright. Keep the height of the figures about half to three-fourth of the height of the box.



Place the figures in the box and fix the polythene cover over it. Use a stapler to fix it in position, if required.

Rub your dry hand over the polythene paper (or use fur) to produce static charge. When the charge is produced, the figures will get attracted and hence get pulled up.

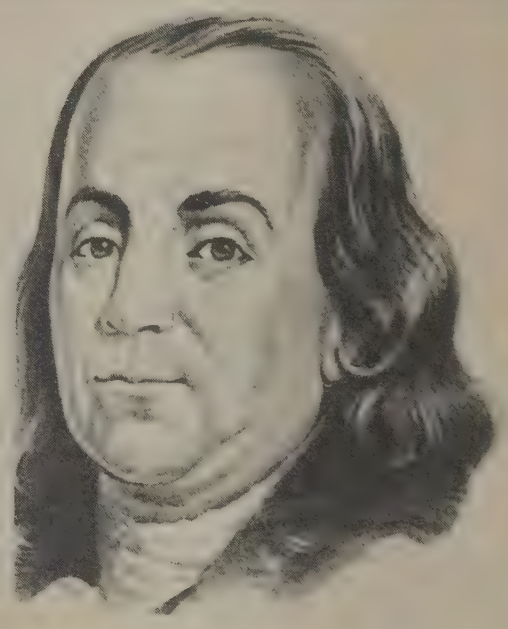
You can also make a transparent side-window to observe the show.

BENJAMIN FRANKLIN'S KITE

We had described Franklin's experiment at the beginning of this article. Here's the actual experiment described by Franklin in a letter to a friend :

> To the top of the upright stick of the kite's cross is to be fixed a very sharp pointed wire, rising a foot or more above the wood. To the end of the twine, next the hand, is to be tied a silk ribbon, and where the silk and the twine join, a key may be fastened. The kite is to be raised when a thunder gust appears to be coming on, and the person who holds the string must stand within a door or a window or under some cover so that the silk ribbon may not be wet; and care must be taken that the twine does not touch the frame of the door or the window. As soon as any of the thunder clouds come over the kite, the pointed wire will draw the electric fire from them, and the kite, with all the twine, will be electrified, and the loose filaments of the twine will stand out every way, and be attracted by an approaching finger. And when, the rain has wet the kite and the twine, so that it can conduct the electric fire freely, you will find it stream out plentifully from the key on the approach of your knuckle. At the key, the phial [an early form of capacitor] may be charged, and from electric fire thus obtained, spirits may be kindled, and all the other electric experiments be performed, which are usually done by the help of the rubbed globe or tube, and thereby the sameness of the electric matter with that of lightning completely demonstrated.

Now the question is, why did Franklin use a silk ribbon between the key and his hand? Why was the wire attracted to his finger and why did the loose filaments stand out?



Why wasn't Franklin eloctrocuted?

In Europe, G. W. Richman was killed while trying to repeat Franklin's experiment. So don't try it, even with Franklin's precautions mentioned in his letter above.

QUESTION & ANSWER

ow do "freak" transmissions of TV signals occur?

WHEN TV transmitters are placed sufficiently far away from each other, it is normally pected that the transmissions would t interfere with each other even ien they operate on the same fre- ency channel. But this is not quite

For instance, when the earlier low- wer TV transmitter operated at the ordarshan Centre, Madras, viewers en received, in the evenings, TV ogrammes from the Calcutta station ng with that from the local station. th the TV transmitters operated on same frequency channel. This uble reception was all the more ominent in locations south of the dras TV transmitter when the eiving aerials of the domestic TV were oriented north, towards both TV transmitters in Calcutta and dras. A similar phenomenon has en observed in the Bombay-Pune ion on several occasions. The Pune tion often receives TV signals m as far as Karachi along with nals from the Bombay station eived for relaying. Both the signals on the same frequency.

This interference is said to occur inly during certain periods of the and in certain seasons. Surprising- the disturbance was more marked en the receiving aerial at Pune was htly off-oriented from the direction the Karachi transmitter towards mbay.

Such freak transmissions of pro- mmes for short periods from distant nsmitters are received randomly. ogrammes from the Calcutta station ve been received at Bangkok and se from Tashkent (USSR) in south dia. By themselves, such program- s may be received as "welcome ests", and even enjoyed by viewers. t the trouble is, they come riding, perimposed, on a popular local ogramme, and both get mixed up.

TV signals are generally high- quency radio waves. TV stations at lcutta, Madras and Bombay trans- t signals in the very high frequency HF) range, Band-I, Channel-IV tween 62·25 and 67·75 MHz (mega- tz; one MHz = 1,000,000 cycles second). Because of this very high quency, the signals travel almost by line-of-sight path, or in a straight e, like ordinary light. So if there are stacles, like a tall building or high ls in the path of the signals, they struct the signals and cast a hadow" in areas behind the obsta- s, just as obstruction of light by a hill or wall causes a shadow beyond. And the reception of TV signals will be quite poor in this shadow zone.

Depending on the power of the transmitter and the heights of the transmitting and receiving aerials, the maximum (radial) range of a TV transmitter is usually limited to about 80 to 100 km. TV programmes from Calcutta are, therefore, not expected to be received at Madras, nor that from Karachi at Pune. The distance, in both the cases, are many times more.

How then do such freak transmissions occur? What is the mechanism by which such long-distance propagation of TV signals occurs? So far, scientists and engineers thought that this might be due to certain meteorological conditions in the troposphere which caused the signal-ray to bend along the curvature of the surface of the Earth. The troposphere forms a very small portion of the atmosphere — from 5 to 13 km in height. Its temperature decreases with increase in height at the rate of about 6·5 degrees Kelvin per kilometre. In this region, sometimes meteorological conditions — involving temperature, gaseous pressure and water vapour content — undergo fluctuations. Under certain favourable conditions, propagation of radio waves covering a wide range of frequencies from about 50 to 50,000 MHz is possible but to an average distance of about 600 km only. Propagation to greater distances is possible, though infrequently, by a phenomenon known as "ducting". Nearness of the sea may complicate the propagation as probably is the case with the Karachi-Pune-Bombay TV interference. Tropospheric propagation may thus be one, but not the only one, mechanism for long-distance propagation of TV signals.

To probe further, we must turn to another means of radio-wave propagation — ionospheric propagation (SCIENCE TODAY, January 1976, p. 11). The ionosphere is a region of the Earth's upper atmosphere, from 60 km to over 500 km in height, where the gases present are slightly ionised, that is, some of the constituent particles are rendered positively and negatively charged, mainly by ultra-violet radiation. Significantly high amounts of such ionisation are concentrated in the form of three layers at three different heights in the ionosphere — the D-layer at a height of about 60 km, the E-layer at about 100 km, and the F-layer at about 300 km. When a beam of radio waves of appropriate frequency propagates through one of these layers, the negatively charged electrons, being much lighter than the positively charged particles, interact most strongly with the radio waves; they bend their path of propagation and ultimately reflect the waves back to the Earth. These reflected signals are received on the Earth by aerials at great distances apart (Fig. 1).

Long-range radio communication in short waves are thus propagated by transmitting the signals upwards towards the ionosphere and consequent reflection of the signals. But such ionospheric propagation is limited to frequencies of about 30 MHz only; frequencies higher than this penetrate the ionosphere and get lost into space. TV signals, being of a much higher frequency, would not be usually propagated through the ionosphere.

However, at the E-layer, there sometimes occurs a phenomenon known as the sporadic-E — a sudden sporadic rise in the concentration of electrons. At such times, the density of electrons at this layer is much higher than that in the normal E-layer. The sporadic E-layer can, therefore, reflect back radio waves of much higher

Fig. 2 An imaginary area in the ionosphere "illuminated" by the intense beam of radio waves from the high-power AIR transmitter at Aligarh and the possible ionospheric propagation path of Calcutta-Madras TV signals. The mid-point, or the reflection point, of this path lies near the centre of this area (shaded)

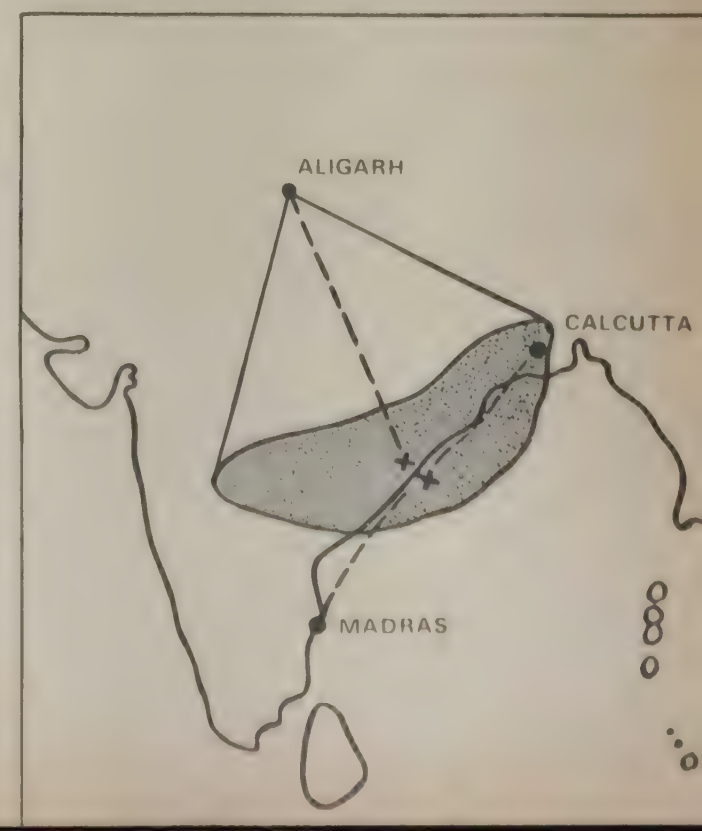
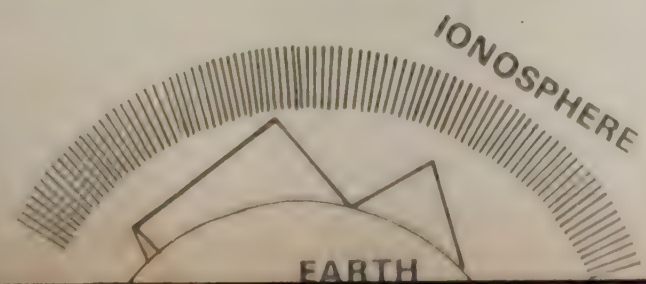


Fig. 1 By repeated and multiple reflections between the ionosphere and the ground, radio waves of certain frequencies can be propagated over very long ranges



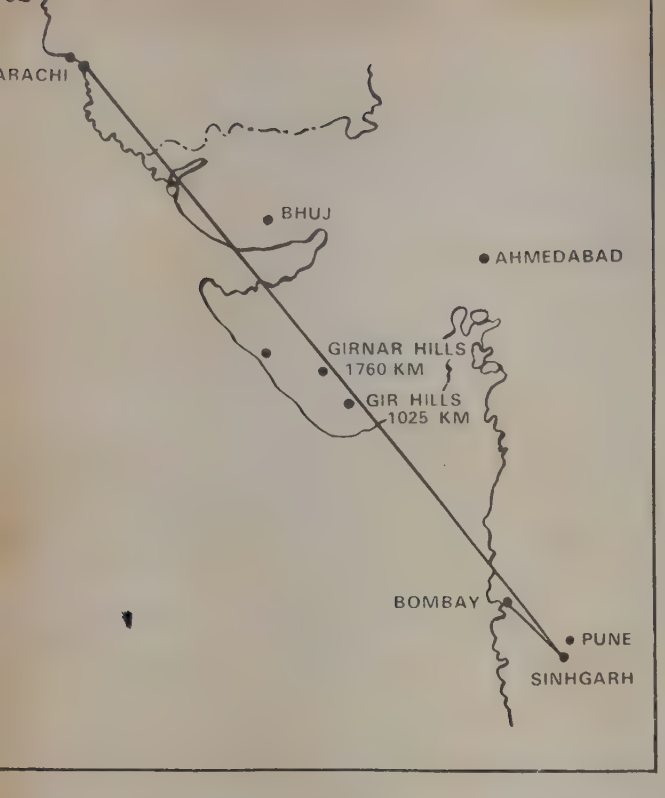


Fig. 3 The distance of TV transmitters at Karachi and Bombay relative to Pune

frequencies than 30 MHz. There is a possibility then that the TV signals are propagated through this sporadic E-layer. But various other considerations rule out this possibility as unconvincing.

Recently, it has been observed that when an intense beam of radio waves from a ground-based high-power radio transmitter strikes an ionospheric layer at a place, the area is temporarily modified and its electron density rises. This artificial " heating " of the area by the intense beam of radio waves thus indirectly increases the capability of that area to reflect radio waves back to the earth; it can now reflect frequencies much higher than the normal. Precisely such a situation exists, or rather must have existed, for TV signals from Calcutta to be ionospherically reflected back to receiving aerials at Madras. It has been found that the beam of radio waves from the high-power transmitter of the All India Radio at Aligarh (effective radiated power—2 megawatt) in its evening transmissions " illuminates " an area in the ionospheric E-layer. And in this area lies the mid-point for reflection of TV signals for the Calcutta-Madras propagation (Fig. 2).

India is geographically vast, and for a country-wide TV coverage, in all probability, a hybrid system combining a large number of conventional land-based TV transmitters with that of a satellite system with ground-based stations, may have to be adopted. The number of TV frequency channels available for the Asian region is limited, and will have to be shared by these transmitters. In that case, the problem of such interference will be intensified.

B. B. GHOSH

[Dr. Ghosh, retired as a research engineer with the All India Radio, and was till recently an emeritus scientist with the Radio Science Division at the National Physical Laboratory, New Delhi.]

ROUND-UP OF RESEARCH

(Contd. from p. 23)

ammonium acetate at pH 6 and passed through a gel chromatograph. The eluted portion yielded 179 mg of the toxin. This was rechromatographed to enhance its activity to 7,000 MU/mg. The toxin was further purified and tested spectroscopically and found identical with tetrodotoxin.

At least, in this instance, there is not much doubt about its role in the animal; the octopus uses its venom to immobilise or kill its prey of small cray fish and crabs. Tetrodotoxin as an offensive weapon was thus put to use by nature long before Ian Fleming realised its spy-thriller potential.

S. RAJAPPA

[Dr. Rajappa, now with the Chemistry Division of the Ciba-Geigy Research Centre, Bombay, had worked with Prof. Robert B. Woodward at Harvard University, USA, on the structural elucidation of tetrodotoxin during 1963–64.]

PSYCHOPHYSIOLOGY

New Light on Left-handedness

IT is generally known that the cerebrum which is concerned with sensory and motor activities is functionally and organically divided into left and right hemispheres. The left hemisphere corresponds to the right half of the body and vice versa. The organisation of the two hemispheres is largely symmetrical but for a few important exceptions. For instance, speech processing, a speciality of man, is done in a so-called speech processing centre which is located in the left hemisphere; speech signals received from the right ear, therefore, can be processed slightly better. Similarly, processing of non-speech sound (music, for instance) is done in the right hemisphere and has a left ear advantage. And whether a person is left-handed or right-handed seems to be determined by which hemisphere is more dominant.

In left-handed persons, there also appears to be some redistribution of functions between the two hemispheres. For example, they have some speech abilities in both hemispheres. Earlier evidence indicated that such persons are at a disadvantage with respect to speech processing capability compared to the right-handed. (This is in addition to the problems they have about locating left-handed scissors, golf clubs, hockey sticks and other gadgets!) If they feel that they got an unfair deal, they now have some good news. Results of recent research by Diana Deutsch from the University of California, USA, indicate that they perform significant better with respect to audio and mu cal processing ability: judging t pitch of the musical tone, to specific. In an experiment (reported *Science*, **199,** p. 559, February 197 76 right-handed and 53 left-hand undergraduates were made to list to 24 sequences of two test ton separated by six other tones. The te tones were either identical or separ ted by a semi-tone. All tones were fro the equally tempered chromatic scal The subjects had to judge wheth the two test tones were the same.

Left-handed subjects were found make significantly fewer mistak (32·5 per cent against 38·1 per cent Again, the moderately left-hand were much better than the strong left-handed, the strongly right-hande or the moderately right-handed. The made only 29 per cent mistakes, com pared to 35·3 to 45 per cent for th other three groups.

Perhaps both the hemispheres the cerebrum have the capability f music processing in the moderate left-handed and this may account f their better performance. Does th ability extend to other music-relate tasks? There is evidence that it doe

Such experiments are important i that they offer some insight, thoug indirect, into brain function. In th particular case, there is strong evi ence for not treating the ambidextrou as a single homogeneous populatio but as composed of two distinc groups: moderately right-hande and moderately left-handed. Such a awareness helps not only in organisin psycho-physical experiments but als in the treatment of neurological an other connected ailments.

P. V. S. RAO

[Dr Rao is a senior research scientist with th Computer Group at the Tata Institute Fundamental Research, Bombay.]

"This plant is surely a city dweller; there's a faint snoring during respiration!"

D STEREO BALANCE DICATOR

A STEREO system consists of a stereo signal source and two separate, left and right, olifying channels with loud-akers. For proper stereo effect it is essary that the relative loudness of sounds from both the channels uld be equal. This is called balanc- of the stereo system.

n a stereo system, with equal ng of all the controls of both the olifying channels, the acoustic puts provided by the loudspeakers not be exactly equal because of difference in outputs from the halves of the stereo pick-up head; difference in amplification be-en the two amplifying channels; difference in reproduction effici-y and directive properties of the loudspeaker systems; (4) loud-aker locations; (5) room acoustics, (6) relative position of the listener. us, to achieve equal loudness from tereo system, the amplifiers are vided with either a separate ume control for each channel or l gang, ie, common volume control n a balance control. The balance trol knob is normally kept in its way position. When this balance trol knob is turned in one direc-, it will increase the loudness of channel while simultaneously reasing the other, and vice versa. ough the stereo balance can be ieved with either the volume trol or the balance control, it omes a tedious job, for the human is not sensitive enough to detect ll differences in the loudness level. h the LED stereo balance indica- as described below, the imbalance of the channels will be shown by the lighted LED of the respective channel. When the balance condition is achieved, both LEDs will remain off. The use of integrated circuit operational amplifier IC 741C provides enough sensitivity to the indicator.

The stereo signals from the left and right channel loudspeaker terminals are rectified with two separate half-wave rectifiers. This produces, across the capacitor, the DC voltage which is proportional to the average outputs of their respective amplifying channels. A part of this DC voltage, from both the rectifiers, is fed to the invert and non-invert input terminals of the integrated circuit operational amplifier IC 741C. Thus, the operational amplifier, with the negative feedback system and inputs to its invert and non-invert input terminals, acts as a differential amplifier having a gain of approximately 10. When the outputs provided by either of the two channels of the stereo systems become unequal by at least 0·4 volts, or more, then the output of the operational amplifier swings sufficiently positive or negative to light the respective LED. When both the outputs of the stereo system are near-equal, then the amplified output provided by the operational amplifier cannot provide sufficient voltage, either in the positive or negative direction, to light one of the LEDs. The output of the operational amplifier must be at least 2 volts or more, either positive or negative, to turn either of the LEDs on. The 1K ohms preset potentiometer should be fixed inside the unit and adjusted while playing the stereo system, so that both the LEDs remain off when proper balance of loudness of left and right channels is achieved.

The pin connections of the IC 741C shown in the diagram are with reference to the 8 pin metal envelope, which is indigenously manufactured and easily available. These numbers also correspond to the 8-pin plastic dual in line package. For the connection details please refer to "You too can do it," SCIENCE TODAY, February 1978, p. 57. The unit works on ± 6 volts to ± 9 volts centre zero DC power supply. The readily available standard, 6·3 volts transformer with positive and negative rectifications, as shown in the diagram, can provide the power requirement of the unit.

This balance indicator can be used with any stereo system having low loudspeaker impedance, ie, less than 15 ohms and one with the loudspeaker output terminals of both left and right amplifiers at the same electrical ground level.

You will need:

Semiconductors :

IC 741C	.. ..	1 No.
Diodes: OA85	.. ..	2 Nos.
BY125	.. ..	2 Nos.
LED	.. .. ..	2 Nos.

Capacitors (electrolytic) :

25 mfd, 12 V	.. ..	2 Nos.
100 mfd, 12 V	.. ..	2 Nos.

Resistors (all ½ watt) :

100 K, 1 No.; 8·2 K, 2 Nos.; 1·8 K, 1 No.; 1·2 K, 1 No.; 470 Ohms, 2 Nos.

Potentiometer (carbon preset) : 1 K, 1 No.

Transformer :

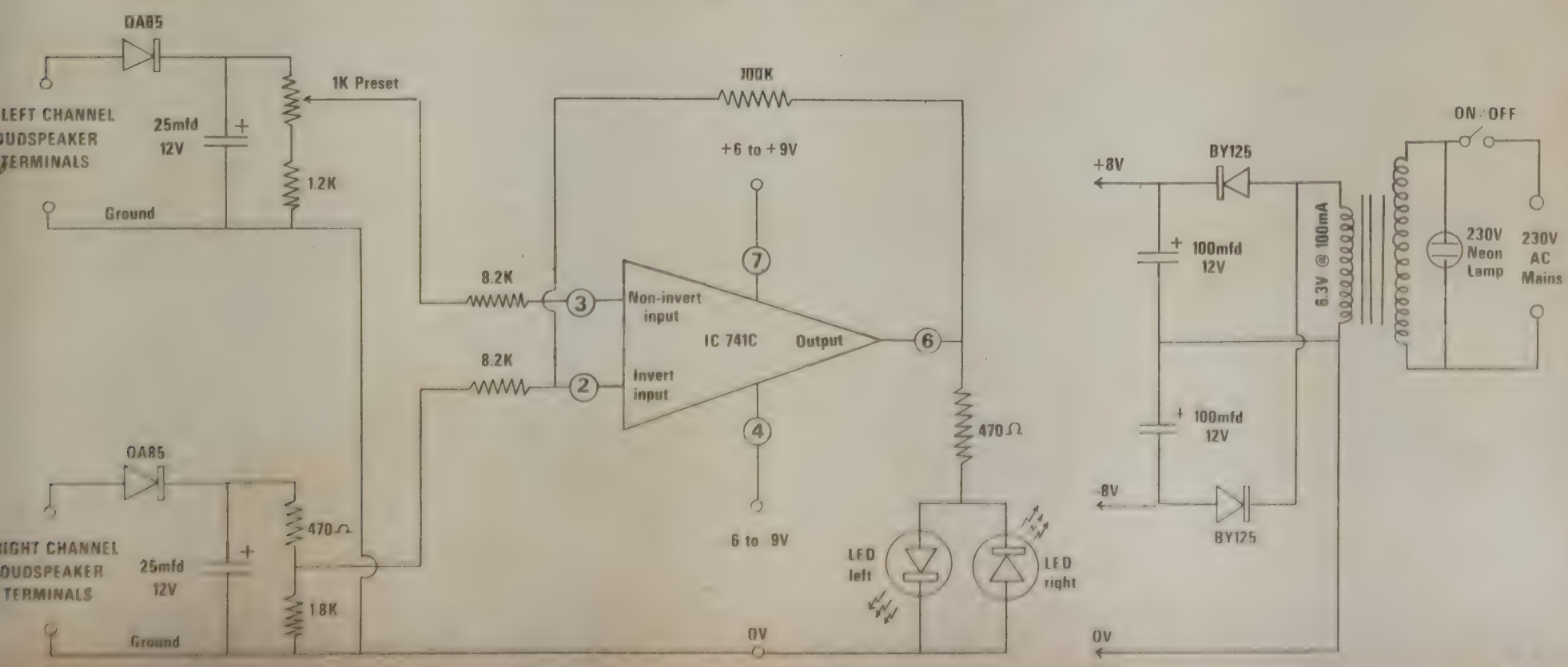
Pri.: 230 V A.C.
Sec.: 6·3 V A.C. @100 mA 1 No.
Neon lamp: 230 V type 1 No.

(Approximate cost of the above electronic components is Rs. 60/-).

Misc :— ON/OFF switches, suitable enclosure, wires, solder, screws, veroboard or printed circuit board.

ANIL V. BORKAR

The offset null connections of the IC 741C are not used in the circuit



The first signs of gum troubl

Plaque
is the invisible film of bacteria that forms around your teeth and gums all the time. If neglected, plaque leads to tartar.

Tartar
collects at the base of your teeth, irritates your gums and causes swelling. Later on, gums and bone may recede causing teeth to fall out.

Bleeding gums
Weak and spongy gums may bleed during brushing. Although this may be painless, bleeding gums can lead to serious problems.

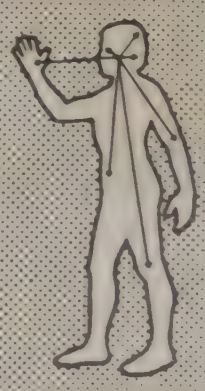
Dentists say

Regular Brushing of Teeth and Massaging of Gums Check Gum Troubles and Tooth Decay.

For proper dental care, brush your teeth correctly and massage your gums—night and morning with Forhan's. And insist on Forhan's Double-Action Toothbrush, specially designed to massage gums while it cleans teeth.

In the smart orange pack

Gum troubles lead to health troubles



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Mention the language wanted.

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the toothpaste created by a dentist

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AWARDS & APPOINTMENTS

irbal Sahni medal

Prof. K. K. Nanda, Head of the Botany epartment, Punjab University, has been varded the Birbal Sahni gold medal for 977.

onour for mathematician

Prof. Shreeram S. Abhyankar, Director the Bhaskaracharya Pratisthana, Pune, as won the Chauvenet Prize of the athematical Association of America for s paper " Historical Ramblings in Algebic Geometry and Related Algebra ". The ize is given for the best paper published the mathematical journals. Prof. Abhyanr's paper was published in the *American lathematical Monthly*, **83**, 1976.

wards for Gopalan, Talwar

Dr. C. Gopalan, Director-General of the dian Council of Medical Research, New elhi, Dr. G. P. Talwar, Professor and Head the Department of Biochemistry at the ll-India Institute of Medical Sciences, ew Delhi, Prof. G. N. R. Rao of the dian Institute of Science, Bangalore, and r. R. V. Tamhankar, Chairman and anaging Director of the Mishra Dhatu igam Limited, Hyderabad, have been ven the Federation of Indian Chambers Commerce and Industry (FICCI) awards r research in science and technology for 977.

Dr. Gopalan and Dr. Talwar share the ward for work in life sciences, including griculture. Prof. Rao wins the award in physical sciences, including mathematics, and Dr. Tamhankar in technology. The awards carry Rs. 10,000 each.

Royal Society Bursary

Dr. S. P. Sen Gupta, Reader in the Department of General Physics and X-rays, Indian Association for the Cultivation of Science, Calcutta, has been awarded a Royal Society, London, and Nuffield Foundation Commonwealth Bursary. Dr. Sen Gupta will work on " X-ray diffraction topography using Lang method and synchrotron radiation " at the University of Durham, UK.

Hora Memorial Gold Medal

The 1977 S. L. Hora Memorial Gold Medal for outstanding work in ichthyology has been awarded to Dr. A. G. K. Menon, Deputy Director, Zoological Survey of India, Madras. Dr. Menon had done extensive ichthyological surveys along the Himalayas, and has contributed papers on the zoogeography and systematics of fishes of the Himalayas and the Indo-Gangetic plains.

Krishnan Medal

Mr. M. K. R. Nair, a geophysicist with the Geological Survey of India, Calcutta, has been awarded the Krishnan Gold Medal by the Indian Geophysical Union for 1977.

NRDC awards for inventors

A thyristor controller developed for defence use by a team of scientists from the Indian Institute of Technology, Madras, Kerala State Electronics Development Corporation Limited (Keltron), Trivandrum, and Bharat Dynamics Limited, Hyderabad, has bagged the top honours in the National Research Development Corporation's Republic Day Awards for inventions. The team is : Dr. B. V. A. Rao, Mr. C. R. Subramanian, Dr. Ramaswami, Dr. G. Sridhara Rao and Dr. V. V. Sastry from IIT, Madras ; Dr. A. Krishnan from Keltron ; and Dr. R. B. N. Chari, Mr. V. Narayana and Mr. R. V. Ramakrishna Sastry from Bharat Dynamics. The nine inventors share an award of Rs. 4,500.

The second award of Rs. 2,500 goes jointly to Mr. K. Sreenivasan and Mr. S. N. Govindarajan of the South India Textile Research Association, Coimbatore, for a two-for-one twisting machine used for doubling of yarns in the textile industry.

Mr. Kumar B. Bhatia, Blue Steel Engineers Private Ltd, Bombay, has been awarded Rs. 1,000 for devising a metal hardness tester, which uses an interchangeable double cone indentor instead of the normal ball indentor. Other awards of Rs. 1,000 each have been made to : (i) Mr. B. Narayana Rao of Southern Industrial Gauges and Tools Private Limited, Madras, for a device for grinding of tools and similar articles, (ii) Mr. Prem Sukh Bansal of Hindustan Copper Ltd, Ghatsila, for developing fluidising nozzles for the concentrate conveying system ; and (iii) Mr. Jagdishchandra R. Modi and Mr. Suryakant S. Trivedi (joint award) of the Ahmedabad Textile Industry's Research Association (ATIRA), Ahmedabad, for cheaper chemical substitutes for citric acid and zinc acetate used in colour processing of textiles.

Mr. Noshir P. Kapadi of Larsen and Toubro Ltd, Bombay, has been given a certificate of merit for his conversion kit for Callahan press which helps increase production of crown shells.

Did Grandma Wear Braces ?

IN the days of grandma, contact lenses, plastic surgery, artificial limbs, braces and such advances were unheard of.

Today these are taken for granted. Like space shots, television, and computers...breakthroughs achieved by men of science and medicine. We get to know about them through magazines—more than from any other media.

For only good magazines can inform and tell us like it really is with vivid colours, pictures and details.

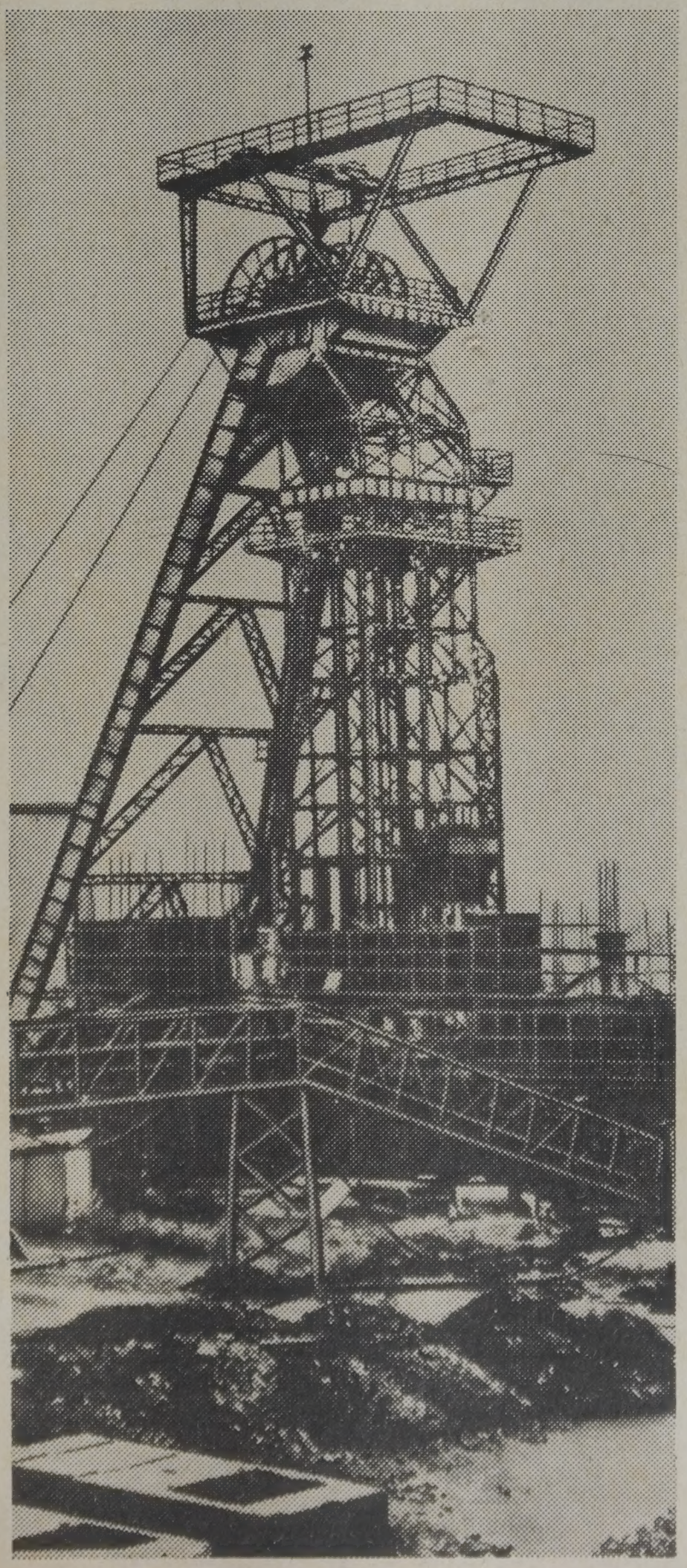
Little wonder, more and more people prefer reading magazines such as Dinaman, Filmfare, Indrajal Comics and Science Today. Which is why more companies are advertising in good magazines today.

Other good magazines published by Bennett, Coleman & Co. Ltd., that cover a wide range of reader interests, are: Dharmayug, Femina, The Illustrated Weekly of India, Madhuri, Parag, Sarika and Youth Times...whose readers are heavy users of the good things in life.

Our Magazines Change Lifestyles

hen you have the industry, the industry will only have you...

Here's an in-depth study



From providing the housewife with her daily requirements, to supplying the vital inputs for major industries and power plants—India's mining industry is basic to all our growth programmes.

Three major areas of mining are Coal, Zinc and Copper—all invaluable to industrial progress.

India's production of Coal has shown an appreciable increase over the last 25 years. From 32 million tonnes in 1950, Coal production touched 100 million tonnes in 1976-77.

There are two major Zinc smelters in India—together constituting an installed capacity of 38,000 tonnes. Future expansion plans and the addition of another smelter will increase the total capacity to 95,000 tonnes.

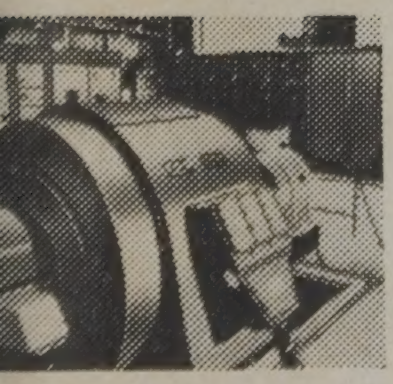
Over 2.45 million tonnes of Copper ore was mined in India in 1976-77, and with the discovery of further Copper ore deposits, its mining is expected to go up considerably.

BHEL—a deep involvement in mining

BHEL has the industry—the diligence and application—needed to serve a variety of industries. Qualities that are making BHEL increasingly popular with vital industries. Like mining.

For the mining industry, BHEL supplies a variety of sophisticated equipment for haulage—of men and materials. Apart from motors for winders and pumps, BHEL also has within its scope, switchgear, controlgear, capacitors and transformers of different capacities for a range of applications.

Yes, be it power or industry, BHEL is committed to growth. The growth of the nation.



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SM 46/73.A

A Cheese Variety Show -courtesy Amul !

Snappy treats and meal thrills:

pinach 'N' Amul heese Meal

0 gm fresh green spinach
cloves ground garlic
small onion, cut fine
cm piece fresh ginger, ground
bsp salad oil • 8 bread slices
lstspn tomato ketchup
0 gm Amul Cheese Powder
0 gm butter • 2 cups milk
sp sugar • 1 tsp salt
sp Cayene pepper
sp black pepper
dash of mustard powder
bsp flour • 1 egg, well-beaten
bsp bread crumbs

ck and wash spinach; cut fine.
at one tablespoon salad oil
a pan and add ground garlic,
ger and onion to it and lightly
. Add spinach and cook till
water is absorbed, take off the
and keep aside.

saucepan melt a tablespoon of
tter, add flour and mix well
gether. Add milk, keep on
rring. Add sugar, salt, Cayene
d black pepper. When sauce
ches boiling point, add Cheese
wder (keep aside a tablespoon
Cheese.) Cook till Cheese
lts, pour the sauce over spinach, add tomato ketchup and fold in beaten egg.

Grease a rectangular ovenproof dish. Cut off the hard edges of bread slices; butter the slices. Arrange four slices of bread in the dish, buttered sides up. Pour half of the mixture on the slices, put another layer of bread slices and pour the remaining mixture. Dab a little butter on it and sprinkle a fine layer of bread crumbs. Top with remaining Cheese Powder. Bake in a hot oven (150°C) for 25 minutes, or till golden brown. Serve hot.

Amul Cheese 'N' Tomato Souffle

1 cup flour • 1 cup butter
$\frac{3}{4}$ cup hot milk
$1\frac{1}{2}$ cups grated Amul Cheese
$\frac{1}{4}$ tsp dry mustard
4 egg yolks • 4 egg whites
$\frac{1}{2}$ cup condensed, canned tomato soup or tomato puree.

Melt butter, add flour, cook until frothy. Then add milk and cook until well thickened. Stir in soup and Cheese and heat until Cheese melts. Remove from fire, add mustard and yolk, adding one yolk at a time, and heating thoroughly after adding each yolk. Beat egg whites until stiff but not dry, and fold them into the mixture. Pour into a well-greased dish and bake in a moderate oven (135°C) for 50-60 minutes. Put the dish in a pan of hot water while baking.

Amul Cheesettes

1 egg • Bread loaf (unsliced)
200 gm Amul Cheese Powder
1 tbsp butter, melted

Cut fresh bread in 3 cm cubes. Beat egg, add tablespoon of melted butter. Dip cubes in egg mixture, roll in grated Cheese. Place on greased baking sheet. Bake in moderately hot oven (135°C) for 15 minutes. Serve hot. Can be served with soup or salad.

Amul Cheese Salad

1 cup grated Amul Cheese
1 tsp minced green pepper (capsicum) • Lettuce
French dressing • Paprika • Salt

Mix Cheese with minced green pepper (capsicum) and serve lettuce or other salad greens with French dressing. Garnish with paprika.

Variations

Serve above Cheese mixture with: sliced pineapple; halves of pear or peach; as stuffing for prunes or apricots; as stuffing for whole tomato; or to accompany any fruit salad.

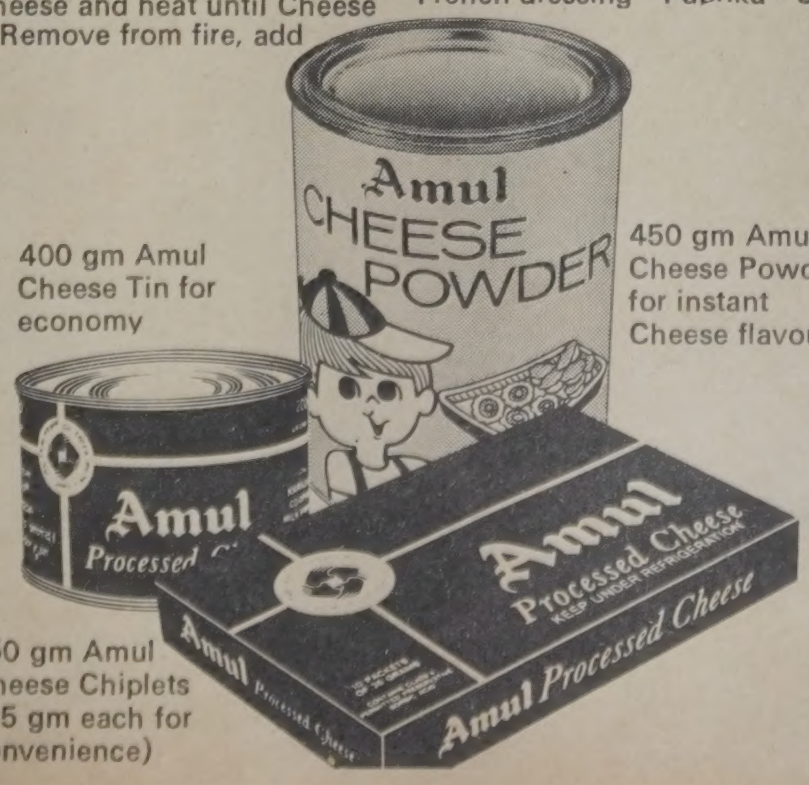
Amul Cheesy Bacon Omelette

6 slices bacon • 4 eggs • Ghee
$\frac{1}{2}$ cup milk • $\frac{1}{8}$ tsp pepper
1 cup grated Amul Cheese

Cut bacon in small pieces and fry in pan until crisp. Drain, reserving 2 tablespoons ghee. Wipe with a paper towel and put fat back in pan. Blend eggs, milk and pepper and pour into the hot pan. Lift edges of omelette as it cooks, letting runny part of omelette go underneath to cook. When eggs are beginning to set, sprinkle with bacon pieces and then, Cheese. Cover the pan just until Cheese melts, fold half the omelette over. Serve hot.

CHEESE NUTRITION

Cheese is more than flavour. It is a source of high quality protein as good as meat or fish. And what's more, protein in cheese is pre-digested, therefore easily assimilable by children, invalids and convalescents! Cheese has 23% protein and is rich in calcium and Vitamin A content. 8 volumes of milk reduce to 1 volume of cheese. Good, rich nutrition that makes a splendid meal.



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450 gm Amul Cheese Powder for instant Cheese flavour

250 gm Amul Cheese Chiplets (25 gm each for convenience)

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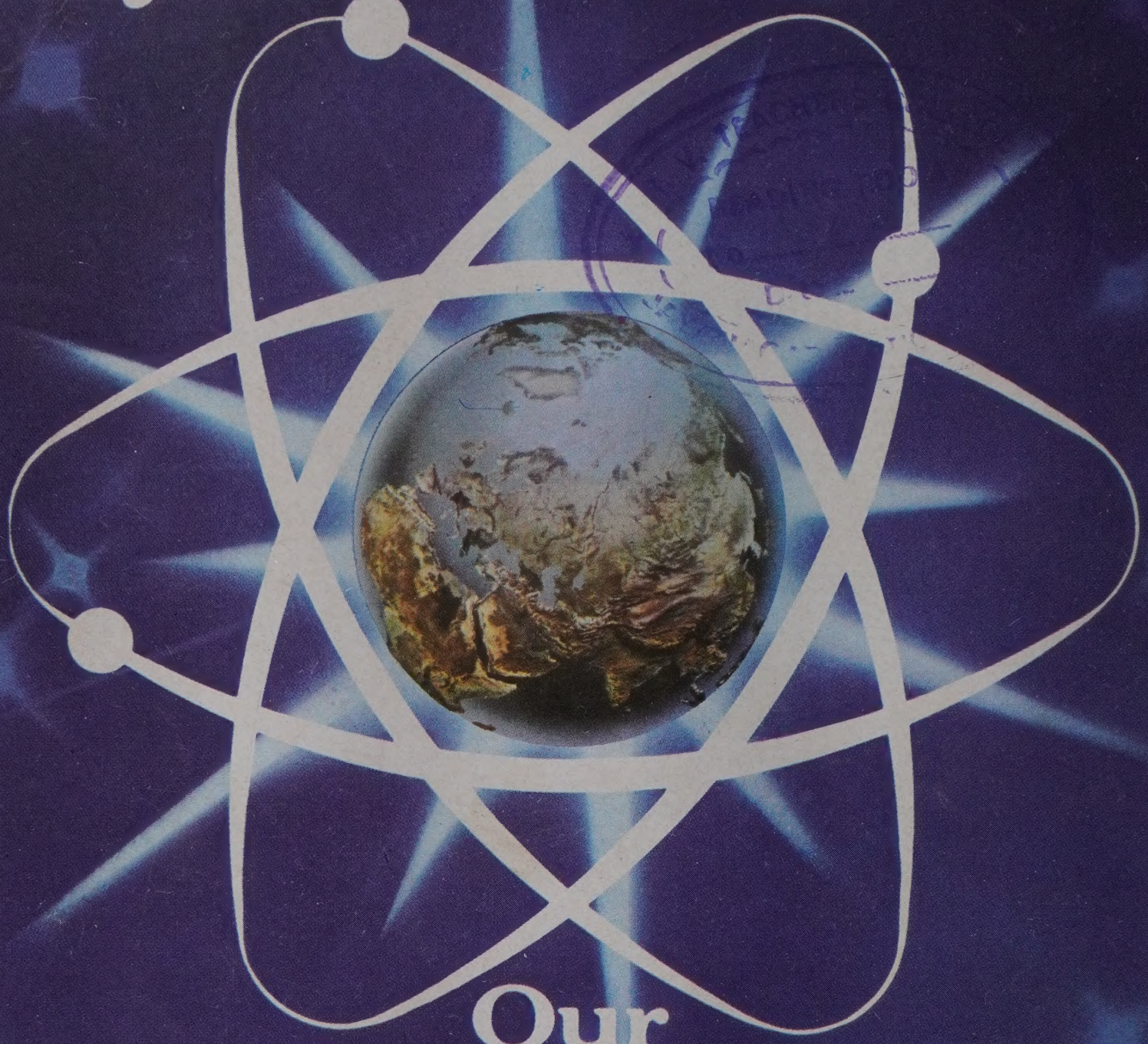

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